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WM. A. ROSENBAUM, Editor Patent Department.
WALTER T. HUNT, Advertising Department.

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The Brooklyn Station. THE paper read by Mr. C. J. Field at the Kansas City Convention, and published in full and illustrated in this week's issue will repay careful perusal. The sound, practical suggestions of Mr. Field will commend themselves to electric light men.

Phonographic Reminiscences. THE address by Mr. E. H. Johnson at Kansas City, in which he briefly reviewed the early history of the phonograph, will be read with interest. It seems that the fact that the phonograph was a talking machine was discovered by accident. Mr. Johnson, however, proceeded at once to turn this knowledge to practical account. His address will be found in full in this issue of THE ELECTRICAL WORLD.

The State Investigation. THE New York Senate Committee, which is to probe electrical matters in this city, and elsewhere, if necessary, began its work last week, and will resume it again at the end of the week. It cannot be said that the work of the committee promises to have much useful result. There is an indication that it may be used as a means of restricting voltages in this State, and if so, we can but hope that the effort will fail, just as it did in Virginia. What is wanted is regulation, not restriction.

Triumphant Electricity. IN its issue dated June, 1875—less than fifteen years ago—the *American Gas Light Journal* said: "We believe that gas can put electricity to shame in nearly all directions of efficiency and economy; and we urge upon those in whose power it lies, and whose part it is to accomplish that, to see that it is done so thoroughly as to effectually change the ideas and opinions imbibed by the public mind during the recent boom in electricity." Those who read in the present week's issue of THE ELECTRICAL WORLD the papers presented at the Kansas City Electric Light Convention, and the discussions upon them, must smile when they see such a prediction as the above. Verily, time works wonders, and in no department of applied science has this been more true than in electric lighting and power.

President Perry. MR. MARSDEN J. PERRY, of Providence, R. I., the newly-elected president of the National Electric Light Association, was born in Massachusetts in 1849. He settled in Providence at the age of 20, where he is still engaged in the banking business under the firm name of Perry & Co. His connection with the electric light industry dates back to 1883. The business sagacity and forethought he has displayed, and the rare executive skill he has shown in the management of the properties he has had under his control, stamp him at once as eminently fitted for the important distinction conferred upon him at Kansas City. The association, in selecting him as its presiding officer, is, however, perhaps to be congratulated quite as much as is Mr. Perry.

Neither Dead nor Sleeping. IT IS less than eleven years ago, namely in April, 1879, that the *Journal of Artificial Light and Sanitary Gazette* said of electric lighting: "We have always predicted, even during the height of success, the death of electric lighting, and our prophecy is not far short of becoming verified. Although not actually dead, it is slowly dying; it is even now in its last struggles, and has retired from active life some time since." Paragraphs like this are exceedingly amusing reading at the present time, when the large attendance at the recent Electric Light Convention, and the number of important papers read on that occasion, exemplify in a most unmistakable manner the phenomenal growth and progress of the electric lighting industry. For a business that, according to so eminent an authority, was in a moribund condition a decade ago, electric lighting certainly shows wonderful vitality. Never before, as a matter of fact, did the business have a more come-to-stay appearance than it has to-day.

Electric Railway Potentials. IT may be considered as a fortunate circumstance that the pioneers in the electric railway field fixed the limits of the potential for operating electric railways in the neighborhood of 500 volts, and, if we are not mistaken, Mr. C. J. Van Depoele was the first to adopt this as his working standard. That the choice was a wise one is exemplified by the total immunity from fatal shock which has thus far characterized the operation of electric railways. In these days of constant striving after higher potentials, it is gratifying to note that through the efforts of the National Electric Light Association the leading electric railway companies have signified their intention of adopting 500 volts as their permanent standard. The necessarily bare wire required overhead makes a safe potential such as this obligatory, and it is a matter of congratulation to note that the question of safety has been made subsidiary to that of expense.

Electric Railways. No paper presented at the late Electric Light Convention was listened to with more interest than that by Mr. F. J. Sprague on "Electricity as Applied to Street Railways." Mr. Sprague treated the subject in an exhaustive, clear and able manner, and his paper is a most valuable contribution to the important, timely and growing subject of which he treats. The paper was read after word had reached the convention of the injunction recently granted by Judge Taft at Cincinnati; and in addition to the subject proper Mr. Sprague discussed at length in his paper the legal aspect of the controversy between telephone companies and electric street railway companies regarding trolley wires. The paper is published in full in this week's issue of THE ELECTRICAL WORLD, and will, we are sure, be read with much interest, not only by electric light and electric railway men, but also by those connected with telephony.

The Convention. BY general consent, the Kansas City Convention of the National Electric Light Association just closed, is considered the most important meeting that the Association has yet held. The papers presented were of a most valuable and practical character, while the discussions were so good that it seemed almost sacrilege to "cut them down." We are, therefore, devoting no fewer than 32 pages in this issue to the Report of the Convention. This is a much larger space than we have devoted to the proceedings of any previous convention. The entire number of reading pages in the present week's issue is 36. This, also, is more reading matter than THE ELECTRICAL WORLD has ever previously published in any single issue. Although the great length of the report and the amount of work involved in getting it to press so promptly, render it impossible to mention many things connected with the convention that we otherwise would, we think we voice the general sentiment in saying that to Mr. Weeks, the retiring president, and to the executive committee, the local reception committee, and Secretary Garratt, too much praise cannot be accorded. They all, individually and collectively, exerted themselves to the utmost, and to their efforts the great success of the meeting is unquestionably due. The reception of the Eastern delegates by the Chicago Electric Club was so complete, so perfect, and so characteristic of genuine Western hospitality, that nothing that could be said in cold type would do the subject justice.

Mutual Insurance. As a part of their report at the Kansas City Convention, the Committee on Harmonizing Electric Light and Insurance Interests incorporated and recommended the prospectus issued some time since, and published in THE ELECTRICAL WORLD of Feb. 1, relating to the establishment of the Electric Mutual Insurance Company, for insuring central stations on a basis similar to that which has been adopted by the Factory Mutuals of New England, and which has been proved eminently secure and successful. We understand that already 49 stations, representing an insurance risk of upward of $1,000,000, have signified their approval of the plan and their willingness to co-operate. The Thomson-Houston Company has also written a letter recommending and approving the scheme. The confidence felt in the character, experience and judgment of the men who advocate and who will probably organize and practically conduct the enterprise is such that the very best results may be fairly expected. It certainly promises relief from two evils—faulty and dangerous construction, with its attendant risks, and excessive rates and frequently unjust discrimination which have too long been imposed upon and borne by the generating stations.

Carbons. ALTHOUGH the last few years have witnessed a steady reduction in the price of carbons, their cost still plays a not inconsiderable part in the running expenses of an arc light station. It is eminently proper, therefore, that the electric station manager should be well aware of the quality of his carbons. As in the case of coal, a cheap article may, on account of its poor life and low light-giving quality, be dearer in the long run than a more expensive one. In either case it is only by a careful test and the tabulation of the results, that a proper conclusion as to the value of the material to be employed can be arrived at. This is well brought out in the paper read at Kansas City by Mr. E. F. Peck, who, by the expenditure of a small amount of time and trouble, was able to select the carbon best suited to his purpose. It is well, however, to bear in mind that the question, Which is the best carbon? is one that is dependent upon circumstances. Thus with a lamp operating at a certain voltage and current, one quality of carbon will be found better adapted than any other, and as the different arc light systems in use vary in the manner pointed out, it would be well for station managers to make individual tests on their own circuits in order to be certain of securing the carbon best suited to their wants. The recent work by Mr. Louis B. Marks at Cornell University, referred to some time ago in our columns, also sheds some light on this important question.

The Double Trolley Decision. THE decision just rendered by Judge Taft, of the Superior Court, at Cincinnati, in the litigation between the telephonic and electric railway interests in that city, as mentioned in our columns this week, is an important one, though it cannot be regarded as final. Judge Taft rules that the electric railway people must adopt the double trolley method within six months, with leave, however, to apply to the court for further time. It will be remembered that at Eau Claire and Harrisburg the decisions have gone the other way, being in favor of single trolley operation, so that the position to-day is practically that of a drawn battle. We do not believe that the extension of electric railway work will be arrested at all, even if the Cincinnati decision be maintained on appeal. In the larger cities the adoption of the complete metallic system for telephones is, as we all know, only a question of time, and was discussed and earnestly recommended by telephonists themselves long before the electric railway had the slightest chance of adoption in any but the smallest towns. As for the places of lesser size, it would seem that the adoption of what is known as the McCluer remedy would reasonably meet the contingency, and might be partly paid for by the electric railway company. And lastly, we may surely hope by-and-by to see some thoroughly workable double trolley system, for large services, devised by ingenious electricians. There would be "big money" in it. By the way, why do not some of our telephone friends work out such a system and get it broadly patented? They would thus secure a double prize.

Safety in Electric Lighting. THE paper read by Prof. Elihu Thomson before the National Electric Light Association is one that will well repay careful study, as it undoubtedly contains the mature opinion of one who is entitled to speak authoritatively on this question. Prof. Thomson remarks at the outset that it is folly to attempt to conceal from ourselves the fact that, under certain conditions, the electric current may be a source of danger both to life and property; but that the question as to the ability and means at the disposal of the electrical engineer to make the distribution of the electric current safe, admits of no doubt. Prof. Thomson puts himself squarely on record when he shows that the question is not one of high or low potential, or of overhead and underground wires, but is one going beyond that, involving in the first place the question of insulation, and then the adoption of such measures and devices as are known to be capable of counteracting or preventing abnormal conditions of service. The many points touched upon by Prof. Thomson, and the examples he gives in support of his views, are full of interest. Thus he advanced a very plausible theory of the possible origin of some manhole explosions which have taken place, holding them to be assignable to the volatilization and ignition of the asphalt compounds surrounding the buried wires. The remedy for these explosions Prof. Thomson discerns to be the thorough ventilation of the underground systems. It is interesting to note also what Professor Thomson considers to be as safe a system of incandescent light distribution as can be devised, and which consists in "a properly arranged double wire cable, well insulated, constituting the primary line, laid in ventilated pipes underground, transformers connected therewith, also inclosed in a grounded metal case, in the cellar of a building, a secondary line of low potential, grounded or provided with safety devices as mentioned." We think Professor Thomson has done well in setting this question in a clear light before the members of the association.

NEW BOOKS.

ANNUAIRE, 1890, DU BUREAU DES LONGITUDES. Paris, 1890. Gauthiers-Villars & Fils. 794 pp., 3½x6 in. Price, 50 cents.

This annual contains the usual useful information relating specially to astronomy, and embraces, in addition, many valuable facts and tables on terrestial magnetism, heat, sound, light, electricity, and chemistry, and makes a very handy reference work for many of the physical constants employed in practical and theoretical work. Besides this, the annual contains the orations delivered at the inauguration of the statue of Le Verrier by M. M. Fizeau, Mouchez and Tisserand. It also gives the reports of the International Committee for Photographing the Heavens, the Congress of Celestial Photography, and the International Aeronautic and Colombophile Society.

LES ALLIAGES. By W. Chandler Roberts-Austen. Translated by Gustave Richard. Paris, 1890. Gauthiers-Villars & Fils, 81 pp., 5 × 7 in. Price, 60 cents.

This is an excellent translation of Prof. Roberts-Austen's studies on alloys, in which we need only draw particular attention to the curious chapter dealing with alloys from the standpoint of their artistic application. The metal workers of the East, especially those of Japan, obtain curious effects by using alloys, the composition of which was unknown until recently, and is revealed for the first time by this work.

TRAITE THEORIQUE ET PRATIQUE D' ELECTROCHIMIE. By Dr. Donato Tommasi. Paris, 1890. E. Bernard & Cie. 1,100 pp. 7 × 10 inches.

This completes what we have already designated as the most complete work on the subject of electro-chemistry in its broadest sense. The author has delved into the depths of the literature on this subject and has collected material of great value, relating not only to the electro-chemical applications—electrolysis, electro-plating, etc.—as applied to metals, but extending them to the application of electrolysis in bleaching, rectification of alcohols, electrolytic analysis, etc. In fact he has covered the field in a remarkably complete and exhaustive manner. The final parts contain an excellent index to the memoirs and works on electro-chemistry, beginning with the year 1784; and the index to the whole work is carried out with great care, and is indeed one of its most valuable parts. We can heartily recommend this work as one of the best that has yet appeared on this subject.

The New A. B. C. Motor.

The designing of small motors has led to a variety of forms almost as great as that to be found among the larger sizes, but in a certain sense these small machines present opportunities for carrying out ideas which are not always practical in the larger ones. Thus, while it has often been pointed out that the lamination of the field magnets would be a desirable thing to carry out in motors generally, constructors have not yet adopted this plan for large machines, but for the small ones the plan is undoubtedly feasible and has been resorted to in several instances.

Among the recent additions to the small motors of this class is that manufactured by the A. B. C. Motor Company,

FIG. 1.—THE NEW A. B. C. MOTOR.

of this city, and which was designed by Mr. Brown. The motor, which is shown in perspective in the accompanying engraving, Fig. 1, was designed so as to obtain, with a small expenditure of current, a maximum amount of magnetism, and to produce a machine that would do its work at a high rate of efficiency over a wide range of power and at a moderate and constant speed under all loads. The laminated field magnets, of course, permit the use of sheet iron, the only form in which soft, pure metal can be obtained of regular quality. The several laminated sections, as shown in the accompanying illustration, Fig. 2, are bound together, not as usual, by means of bolts passing through them, but by an ingenious arrangement of rods which are recessed in the notches shown, which are formed in the outer edges of the core plates. By means of this construction any irregularity caused by inexactness in the separate punching of the holes, as usually employed, is rendered impossible. The field magnet has but one coil, and no yoke is therefore necessary in its construction. The field magnet is also ample in cross-section, and designed to be as short as possible, the under space between the limbs being occupied by the coil and the armature. This form of construction assists materially in the production of a magnetic circuit of very low resistance.

The armature employed is wound with great care and thoroughly insulated, and can be removed very quickly if necessary. The brushes, being at the top, can also be readily inspected, and the armature being elevated, it is not necessary to place the motor on a special base when required for fan purposes. The mechanical construction of the motor throughout has been carefully attended to, and the entire machine is very well worked out in all its details.

A Government Telegraph Scheme.

Postmaster-General Wanamaker appeared before the House Committee on Post Offices and Post Roads at Washington on February 11, to urge the support of the committee to his postal telegraph scheme. He explained that he wanted no large appropriation, but simply wanted authority to enter into contracts to connect a certain number of post offices with each other by telegraph, by leasing wires and instruments to be operated by post office employés. He was not proposing, he said, that the Government should purchase or build a telegraph line, nor the creation of a new body of employés, but simply the utilization of the office buildings, clerks, and carriers now in use, and by convenience and economy of service to greatly accommodate the public in a business that should not be divorced from the post office, as it was nothing more nor less than the carrying of messages.

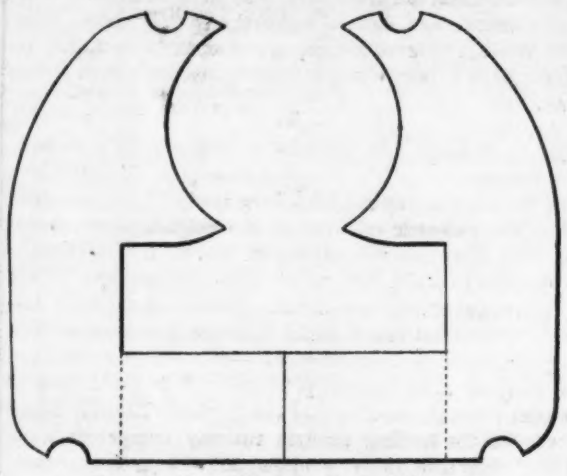


FIG. 2.—THE NEW A. B. C. MOTOR.

The bill prepared by Mr. Wanamaker authorizes him, with the concurrence of the Attorney General and the Secretary of the Treasury, to enter into contracts for a term of ten years, and makes provision for the application of the postal service to the money-order service under certain limitations. One section of the bill reads: "The charges in any one State shall not exceed 10 cents for messages of twenty words or less, counting address and signature, nor over 25 cents for any distance under 1,500 miles, nor over 50 cents for any greater distance, said rates and rules and regulations to be prescribed by the Postmaster General."

Report on Execution Apparatus.

The commission to test the electric execution apparatus in State prisons has made its report to Prison Superintendent Lathrop, Dr. Carlos F. Macdonald is the president of the commission. The report is very voluminous. The questions to be solved were, in the main, whether the apparatus would kill, what number of volts was necessary, and what kind of wire should be used. It was found that German silver wire was the best, and that about 900 volts was the maximum needed for horses and other large animals and about 400 for smaller animals. At Auburn a horse and calf were successfully experimented upon, and efforts made by Dr. Fell, of Buffalo, by the aid of improved machinery, to resuscitate the animals failed entirely, thus proving, the report says, that it was not a case of suspended animation. The committee experimented in like manner with each apparatus and similar results were obtained. The number of volts attainable in each prison—Sing Sing, Auburn and Dannemora—was far in excess of that required.

The commission expresses the opinion that each one of the apparatuses can be used successfully, and that death by electricity can be accomplished within four seconds. There is, in the commission's opinion, no cause for imagining that there will ever be any failure of result. In the opinion of the committee the apparatus had not been set up in a very workmanlike way.

Hill's Double Pole Converter Switch.

However well the secondary wire is insulated from the primary wire in an alternating current converter, yet when a lineman has occasion to do any work, either on a converter or on the secondary wires, it is a desirable matter to know that the primary circuit is cut off by means of a double switch. Recognizing this want, Mr. Warren S. Hill, of Boston, the inventor of so many useful devices, has produced a double pole switch, which effectually avoids any possible danger in handling a converter or the secondary wires, and which we illustrate this week. As will be seen by the accompanying engraving, the mechanism of the switch is incased in an iron box, with a waterproof door with glass front. This door is never opened except in making the connections. The switch is made in the usual Hill type, with a lever, which forces down a V-shaped copper contact of thin pieces of copper sheet into suitable sockets, forming a frictional solid connection. By means of strong springs, the switch cuts out very easily by a touch on the handle, and cuts out so quickly that all tendency to sparking is avoided. The switch is placed in series in the primary circuit, the current entering at the top of the box, down through one pole of the switch through the converter, back through the other pole of the switch and out at the other wire at top of box. When in use and the converter is cut out, therefore, an effectual barrier is placed in the way of any current from the primary circuit entering the converter, and absolute immunity from danger may be enjoyed by linemen. Such a switch should, we imagine, become extremely useful to all stations using the alternating system, and Mr. Hill is now filling a large order for one of the best known electrical contractors in New England. who intends to use them in all his alternating construction work. The switch is manufactured and sold exclusively by Mr. W. S. Hill, Boston, and, by reason of its merits and moderate price, should recommend itself to all electrical engineers.

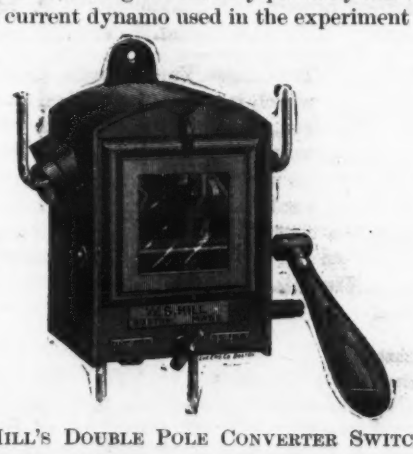
The Edinburgh Electrical Exhibition.

The exhibition buildings are, we hear, making rapid progress. There are two principal buildings—one to contain the electrical and engineering exhibits, having a central span of 80 feet, and two lateral galleries of 20 feet and 15 feet on each side, and about 800 feet long; and the other to contain the general industrial section, covering a space of about 250,000 square feet. These buildings present very handsome elevations, and already form prominent features of the district. The open weather has also facilitated the laying out of the grounds. The arc lighting has been placed in the hands of the Brush Electrical Engineering Company, and Messrs. King, Brown & Co. undertake the principal portion of the incandescent system. There will be two special railway stations—North British and Caledonian—within the exhibition grounds. Tenders have also been invited for the working of a small electric railway. The line is intended to be not only a mere demonstration of the capabilities of electric traction, but to provide the visitors to the exhibition with a means of getting from point to point in the grounds.

An Electro-Magnet in Electric Welding.

PROF. JOHN E. DAVIES.

In Mr. Coffin's method of electric welding, described by you in your issue of Feb. 1, you state that an electro-magnet is placed beneath the welding arc for the purpose of increasing the resistance at the joint, and thereby the heating effect of the current. It occurred to me to see whether the resistance of the arc is notably increased by the well-known experiment of deviating it laterally by a magnet brought close to the arc. For this purpose I placed a volt meter at the terminals of the lamp, and an ammeter in the dynamo circuit. The latter did not move a particle, as was to be expected, owing to the very perfectly self-regulating constant current dynamo used in the experiment; but the



HILL'S DOUBLE POLE CONVERTER SWITCH.

volt meter indicated a steady rise as the magnet was gradually placed in its most advantageous position. Generally the lamp fed so promptly that there was but slight chance for the rise to become large; but in a non-adjustable arc it would doubtless be considerable; as it was, I found that on holding the magnet in its strongest position, and *when the lamp was unable to feed rapidly enough*, the index of the volt-meters would go up from 35 volts to 50 volts, and back again, as the feeding was accomplished.

It is very evident that for a *continuous* current then, the resistance at the weld would be increased, and thereby, presumably, the heating effect. It seems likely that the same would be true of the mean resistance in an alternating current. In fact the very oscillations from side to side of the current which, it would seem, must take place in an alternating current arc under the influence of a powerful magnet, would, of themselves, tend both to heat the junction and raise the resistance. It would be an interesting experiment to ascertain with a Carden, or other volt-meter adapted to alternating currents, whether a marked change took place in the resistance of an arc formed at the terminals of a Jablochkoff candle by an alternating dynamo, when a magnet is put near such arc, and in the proper position to produce its deviating effects upon it.

The Kansas City Electric Light Convention.

The Eleventh Convention of the National Electric Light Association, just ended, leads all previous meetings of the Association in the amount of work done, the actual results accomplished and the value and importance of the papers and discussions. In the matter of entertainment and enjoyment, the courteous attentions everywhere received and the pleasure derived, no meeting has yet surpassed it. Long journey though it was for the Eastern delegates, no one regrets the trip, for it was made memorable in many ways, and the superb train on which the journey of 1,500 miles was made was the finest ever sent out.

Then there was the elegant reception in the parlors of the Chicago Electric Club; the jovial party that there joined the delegation; the attentive reception committee with its long line of carriages waiting the arrival of the train at Kansas City; the social party at the Commercial Club; the C., M. & St. Paul R. R. excursion to Excelsior Springs, and the dinner at "The Elms;" the various invitations received from numerous societies, as well as the freedom of telephone and transit service—all combined to make the occasion one long to be remembered by every delegate.

The general opinion, shared by all, is that too much praise cannot be accorded to Mr. H. C. Sprague, Mr. W. W. Smith, and others of the local committee, whose daily avocations are not such that they can be benefited, either directly or indirectly, by any services they rendered, yet who spared neither time, comfort nor expense to render the stay in Kansas City one that would always be associated with the most pleasant memories. This loyalty to the unwritten law of good fellowship, to the fraternity and to their city is worthy of the highest commendation.

The attendance at the convention was very large, as follows:

ALLENTOWN, Pa.—Harry E. Heller.
ATCHISON, Kas.—J. A. Chisham, Mr. Wells.
BOSTON.—Dr. Robt. Amory, Capt. W. Brophy, F. E. Barker, S. E. Barton, H. J. Conant, D. J. Flanders, D. Killicut, A. F. Mason, A. K. Page, C. M. Ransom, F. A. Wyman.
BALTIMORE.—D. E. Evans, H. C. Tudor.
BUFFALO.—C. R. Huntley, F. G. Raichle.
BRIDGEPORT, Conn.—H. D. Stanley.
BOONVILLE, Mo.—J. F. Gwelich.
BROOKLYN.—C. F. Coles, E. J. Cook, J. F. Munsie, E. F. Peck.
CAMDEN, N. J.—E. A. Armstrong, J. J. Burleigh.
CAPE MAY, N. J.—F. T. Walton.
CARROLL, Iowa.—V. Hinrichs, E. M. Parsons.
CARROLTON, Mo.—James W. Lacy.
CINCINNATI.—G. E. Allen, E. V. Cherry, W. H, Jones, J. C. Hobart, Emile Kahn, Ed. H. Williams.
CLEVELAND.—J. B. Crouse, C. C. Curtis, W. H. Lawrence, W. C. Hayes, B. F. Miles, Frank A. Rogers.
CHICAGO.—J. B. Allen, C. G. Armstrong, Geo. Atkinson, E. V. Cavell, F. W. Cushing, C. H. Cone, A. L. Cloud, E. L. Clark, Geo. Cutter, A. C. Durborow, Jr., A. L. Davidson, D. B. Dean, Fred De Land, J. W. Dickinson, F. E. Degenhardt, D. T. Evarts, C. W. Emery, E. D. Floyd, D. S. Geer, C. E. Gregory, H. A. Glasier, Ernest Hoefer, C. C. Haskins, Geo. T. Hewes, W. A. Kriedler, Alex Kempt, G. A. E. Kohler, W. J. Buckley, G. C. Bailey, A. H. Bauer, S. S. Badger, H. P. Lucas, W. W. Low, S. S. Leonard, H. T. Lockwood, H. E. Longwell, W. C. McKinlock, J. J. Nate, E. L. Powers, W. B. Pearson, John Ritchie, R. J. Randolph, B. E. Sunny, B. H. Schmidt, G. M. Smith, J. H. Shay, A. E. Smith, G. S. Searing, J. Stedman, F. S. Terry, John Young, C. H. Wilmerding.
DALLAS, Tex.—D. M. Clower, Wm. Clower, W. T. M. Mottram.
DAVENPORT, Iowa.—H. O. Woodruff.
DENVER, Colo.—W. H. Emanuel, C. H. Brown, E. W. Rollins, C. H. Smith.
DETROIT, Mich.—J. A. Campbell, J. E. Lockwood, A. A. Robinson, Fred H. Whipple.
EXCELSIOR SPRINGS, Mo.—E. B. Kay.
EAU CLAIRE, Wis.—Carl Kammeyer.
FORT SCOTT.—N. C. Thompson, A. W. Walburn.
FORT SMITH, Ark.—R. H. Browne.
FORT WAYNE, Ind.—Chas. Knight.
FREMONT, Ohio—C. T. Richmond.
FORT WORTH, Tex.—E. J. Jennings.
GREELEY, Colo.—B. D. Sanborn.
HARTFORD, Ct.—C. E. Newton, E. B. Hatch.
HAYES CITY, Kan.—I. M. Yost.
HOUGHTON, Mich.—J. R. Dee, J. T. Daniels.
HUTCHINSON, Kan.—L. A. Beebe.
INDIANAPOLIS, Ind.—F. W. Baugher, Chas. D. Jenney, George C. Pyle.
KANSAS CITY.—Paul Bossart, L. C. Blair, M. E. Bates, Dr. R. W. Brown, A. A. Barron, John Boyle, J. S. Chick, T. F. Clohesey, J. D. Cruise, H. M. Cutler, L. H. Camp, O. H. Ditsch, G. H. Elmore, T. F. English, C. C. English, Ben Friedberg, Bert. Ford, W. B. Grimes, W. B. Grimes, Jr., C. S. Gilbert, G. W. Hart, F. Howard, C. A. Harber, F. K. Hoover, F. K. Holtsinger, I. C. Hubbel, W. D. House, G. W. Johnston, L. S. Jenkins, W. B. Knight, F. A. Kettler, Horace Keefer, Louis Kunz, Edw. Lasell, H. G. McGonnon, C. W. McDaniels, R Macmillian, J. W. Mason, A. H. Morse, G. M. Meyers, T. Mulford, W. F. Osborn, M. S. Porter, H. M. Porter, Floyd Platt, C. H. Rusling, F. H. Reynolds, C. A. Rose, G. H. Schammon, W. T. Sargent, D. K. Smith, A. Wiley Smith, H. C. Sprague, C. H. Talmage, W. H. Woodring, D. A. Williams, E. R. Weeks, Thos. Wolf, W. M. Yenawine.
KEARNEY, Neb.—J. G. White.
JACKSONVILLE, Ill.—Frank M. Doan.
LINCOLN, Neb.—M. J. Bigelow.
LOUISIANA, Mo.—W. T. Johnson.
MCPHERSON, Kan.—J. B. Darrah, B. A. Allison.
MERIDEN, Conn.—F. E. Knight.
MILWAUKEE, Wis.—B. W. Smith.
NEWTON, Kan.—W. G. Oldfield, L. McCormick.
MONTREAL.—W. R. Kimball.
NEW YORK.—P. H. Alexander, C. A. Benton, W. L. Candee, David Chalmers, C. R. Field, C. J. Field, E. T. Greenfield, A. V. Garratt, J. W. Godfrey, R. J. Gray, J. B. Halsted, H. H. Haines, P. H. Hover, Wm. Hammond, E. H. Johnson, W. J. Johnston, J. F. Kelly, W. S. Kelly, H. Ward Leonard, H. L. Lufkin, J. P. McQuaide, F. A. Magee, A. T. Mayer, Geo. Manson, G. M. Phelps, C. W. Price, A. H. Patterson, C. E. Stump, F. J. Sprague, J. A. Seely, C. A. Schieren, Jr., A. J. Stott, H. M. Swetland, Luther Stieringer, F. P. Wisner, J. B. Taltavall, W. S. Turner, G. P. Toby, S. S. Wheeler, B. R. Western.
NEWARK, N. J.—C. O. Baker, Jr., M. Garver.
NORTH EAST, Penn.—A. L. Daniels.
NEW BRITAIN, Ct.—T. H. Brady.
NEW ORLEANS.—E. H. McFall.
OMAHA, Neb.—H. A. Kinney.
PHILADELPHIA.—A. J. DeCamp, W. R. Hood, M. D. Law, G. F. Porter, J. A. Pentz, T. C. Smith, E. G. Willyoung.
PINE BLUFF, Ark.—J. H. Aitkin.
PITTSBURGH.—A. E. Carrier, M. W. Meade.
PEORIA, Ill.—Lafayette Cole, Martin Kingman.
PROVIDENCE, R. I.—M. H. Hartwell, M. J. Perry.
PUEBLO, Col.—C. M. Davis.
QUINCY, Ill.—A. B. Faunce.
RED JACKET, Mich.—J. D. Cuddihy.
RICHMOND, Mo.—J. R. Hamacher.
RUTLAND, Vt.—M. J. Francisco.
SALINA, Kan.—A. Hiller, J. M. Jeffres, Geo. Kreuger.
SPRINGFIELD, Ill.—A. L. Ide.
ST. JOE, Mo.—T. A. Chadwick, J. A. Corby, I. L. Dyer, F. D. Rushing, Frank Yenawine.
ST. LOUIS.—S. P. Baird, F. E. Costello, L. M. Fishback, C. W. Hazeltine, H. S. Graber, G. Pantaleoni, G. Parker, F. H. Pond, P. L. Rose, J. A. J. Shultz, T. J. Wilson.
SYRACUSE, N. Y.—A. P. Seymour.
TOLEDO, O.—C. R. Faben.
TOPEKA, Kan.—J. J. Everingham, W. W. King.
VINCENNES, Ind.—H. W. Frund.
WINDSOR, Ct.—M. E. Baird, A. D. Newton.
WASHINGTON, D. C.—Fred Royce, John Lynch.
WASHINGTON COURT HOUSE, O.—Jerome Penn.
WICHITA, Kan.—J. W. O'Neil, E. M. Reed.
WILKESBARRE, Pa.—J. C. Bridgeman.

FIRST DAY'S PROCEEDINGS.

The Convention was called to order at 12:30 P. M. on Tuesday, February 11th, in the Coates Opera House, by President Weeks, who opened the proceedings by introducing the Mayor of Kansas City, the Hon. J. J. Davenport, who delivered the following

ADDRESS OF WELCOME.

Mr. President, ladies and gentlemen of the convention: To me has been assigned the pleasant and agreeable duty of welcoming you to our city, where many of the most important and interesting conventions that have been held throughout the United States during the years of 1889 and 1890 have sat in deliberation. To none, however, have I extended, in behalf of our citizens, a more cordial and heartfelt greeting than it is now my pleasure and privilege to offer you, whose coming has been a source of pleasant anticipations, mingled, perhaps, with the hope that here in the centre of this great American Union, the verge or margin of that border land of science which Mr. Thurston so graphically depicts, may some day find its beginning—a land where it is said the portrait of the sender of each telegraphic dispatch will accompany the message; where sub-marine and aërial navigation will be carried on successfully by the power derived from stored electricity; where the soft light of the fire-fly or glow-worm will be produced by man, and the problem of the direct conversion of heat into electricity will be solved. The result of your deliberations will be anxiously awaited by the whole commercial world, as well as the scientific, because electricity has given an impetus to the former that has driven and impelled it forward with wonderful rapidity and signal success to its present high state of perfection. The civilizing influences of electricity have extended the confines of education, refinement and culture to the uttermost parts of the earth. You, gentlemen, are the exponents of laws which govern one of the most powerful forces of nature, under the action of which, energy becomes appreciable. You teach us that, like heat, light, or work, it is measurable and can be produced or converted into other forms of energy. By means of this marvelous agency you have already presented to science most wonderful aids by which she has been able to make visible what has hitherto been invisible, to make audible what has been inaudible, and to discover what has not been dreamed of in the philosophy of mankind, for whether its manifestations be considered under the head of static, galvanic or Faradic, it is all electricity—it is all witchcraft with its future possibilities entirely inconceivable except to such research as may result from distinguished and able gentlemen such as compose this assembly. As we hear of these mysterious currents measured by ampères, and of the power by which various bodies resist these currents measured by ohms, we seem to be attaining the condition of life of which Mr. Thurston speaks, or that is so cleverly portrayed by Bulwer in his "Coming Race," in which all are happy and harmonious, seeming to have reached the millennium, evil being held in bondage by the potent "vril" wand, which gives to all alike motive, defensive, and creative power, with also the perfect knowledge of how to use it for the greatest and best good of all. Electricity is our magic "vril" wand, and you are teaching us its capabilities. Six years ago it had not been used upon the broad ocean, that difficult and dangerous field of warfare. When the Navy Department fitted out the frigate Trenton with an electric incandescent plant, the eyes of the world were upon her, eager to see the mooted question settled as to how the glass bulbs and carbon filaments would bear the firing of the frigate's guns. The three years' successful cruise proved so much to the United States and to those foreign countries who are learning to follow in her footsteps that now a man-of-war is not equipped without its incandescent lighting plant and the "arc" for the search-light, which reveals not only the dangers of the surface of the mighty ocean, but pierces her briny depths, detecting death-dealing torpedoes that have been laid for destruction. This faithful servant of man now not only guards the vessel from the inventions of the enemy, but aims and fires the guns, illuminates the sights that the aim may be sure, discharges torpedoes, measures her speed, is the most successful motor for submarine boats, and renders possible a system of visible telegraphy by which communications may be flashed against the clouds and understood at a distance of sixty miles. We welcome you as true benefactors of mankind, the emancipators of the human race from darkness. What you and those of your profession have accomplished within the past years reflects credit upon your country, borders close upon the miraculous, and entities you to imperishable honor and renown. I will not detain you in enumerating your achievements, gained by the most faithful and unremitting labor. Cost—or dollars and cents—is the great obstacle in the way of the speedy and universal adoption of many of your most important discoveries and perfected inventions. Electricity to-day is at its highest cost, and we look forward to the time when, being cheaper, it will accomplish for humanity all that it now promises. It is estimated that at the beginning of the year 1890 $600,000,000 was invested in the electrical industry in the United States; that 250,000 persons depended upon it for their means of living, and that 1,000,000 miles of telegraph wire were in operation—enough to encircle the globe 40 times; 300,000 telephones are constantly talking, and an average of 1,055,000 messages are sent daily, requiring the use of 170,000 miles of wire. The longest distance over which conversation is maintained is 750 miles, *i. e.*, from Portland, Me., to Buffalo, N. Y. Just how many of the musical kind are in use that Mr. Bellamy speaks of I do not know. Four hundred miles of electric railway are in active operation in America. The fastest speed attained in the transportation of passengers has been twenty miles an hour. I believe Mr. Weems has quite recently, at Laurel, Md., upon an experimental track, made two miles a minute, or 120 per hour. There were no passengers upon that train, however, it being used exclusively for baggage, which is hereafter to be sent in advance. At your annual meeting at Niagara Falls, the statement was made that there are in use in the United States 237,017 arc lamps and 2,704,768 incandescent. I hope that the increase will be so great within the next few years that the various companies will find it possible to furnish light and motive power at much lower rates. Electric light is certainly the only form of artificial illumination not injurious to health, and therefore, it is our hope that all classes may soon, in consequence of its cheapness, be enabled to enjoy its benefits. The mystery which seemingly surrounds electric service will in time be dissipated, and it will come to be regarded with less suspicion and fear. Perfection cannot be expected in the use and distribution of such force and power immediately. Danger to human life and property interests are questions in which we are all concerned, but it will not do to condemn without comparison and investigation; also, we may deprive ourselves of valuable agencies and servants whom to understand is to bring us health, wealth, and prosperity. Immense poles, that make unsightly our most beautiful thoroughfares, over which hang a dense mass of wires to obstruct access to our buildings in case of fire, and almost shuts out the light of day, will in time disappear. It was necessary that they should precede the subways now coming into use, but not yet, I believe, admitted to be universally successful, though the Bell Telephone Company had, in 1887, 6,030 miles of wire underground; in 1888, 8,009; and in 1889 have increased it to 17,038 miles. Taking into consideration, however, the service performed and work done through the means of this unseen power, it is pleasing to note that the casualties resulting from its use are less than from any other service. (Applause.)

To the future we can only look with wondering eyes and bated breath, and to you as the workers of miracles. May your deliberations, gentlemen, while here, be as harmonious as the laws which govern the marvellous and wonderful philosophy of electricity.

President Weeks then addressed the convention as follows:

PRESIDENT'S ADDRESS.

At our first convention, held in February, 1885, there were 87 delegates, full of enthusiasm for the good to be accomplished. I believe, gentlemen, that they have not been disappointed in the work of this association. As one of the original 87 I point with pride to five years of broadening and harmonizing influence, and I believe that every central station, every factory, every supply company in the country has felt its impulse toward improvement.

To-day, gentlemen, we number 300, representing not only a wider extent of territory than ever before, but all the leading systems of the United States. A more fraternal spirit now prevails between the electric light and power men and our elder brothers of the telegraph and telephone interests, a pleasant proof of which has been given by the hearty co-operation of their representatives in this city, in preparing for the entertainment of the convention. (Applause.)

The past work of the Association speaks for itself; but our number has so increased, and our sphere of usefulness has so advanced that we must look for work of a better character than was possible in earlier days, when most of our members were new to the duties which they had undertaken. We now need work of more direct practical value to central station men, and theoretical work of a higher grade than that of the past, good as that has been. With this in view, we have endeavored to prepare a programme of such importance, both practically and theoretically, that you will find it good to be here.

The Committee of State and Municipal Legislation will report the organization of State associations, with a view to developing among legislators a full appreciation of the importance and needs of the electrical industries, and to present these industries in their true light. The urgent need is for organization along the lines of legislation and popular education. This can be best accomplished by State associations, whose conventions could advantageously take the place of the semi-annual meetings of this association. Ten of these State associations have been formed, and I hope that before the close of this convention steps will be taken toward the organization of many more.

The increasing interest in railroad work and the immense field for future development in the motor department will render especially pertinent the discussion by Mr. Sprague, and also the work of the Committee on Standardization of Potential on Electric Street Railways, the report of which will be submitted through its chairman, Mr. Lynch.

As the growth of our industry must be chiefly in the direction of incandescent light and power, the discussion to be presented by Mr. Field is of the greatest importance both to central station men, and to all who desire electric service in their homes.

The watchwords of the future are certainly economy of fuel, and perfect insulation, and, while there may be improvements in designs for apparatus, and in methods and means of distribution, and while we still hope for the direct conversion of the energy of coal, the advance of the immediate future should be in the direction of economizing present waste, rather than in the discovery of new facts or principles. (Applause.) Americans are proverbially prodigal and there is an absolute and growing need that waste and loss should be arrested. While the demand for the necessary elements is increasing with the population, the supply of many of those elements is steadily diminishing. Messrs. Babcock and Sickles will doubtless point out lines of economy in the department of steam engineering, and Mr. Smith will present for our consideration another phase of the same question in "A Universal System of Central Station Accounts." The many problems arising in the electrical and mechanical departments of the operation of central stations have left this question to general neglect. But now that we are becoming passably familiar with the tricks of our apparatus, attention is more and more directed to data for comparison with a view to economic methods.

The topic of the hour is certainly "safety." It would seem that in view of the relatively small number of serious accidents connected with electrical industries, we have grounds for some impatience with the present outcry against electricity as a dangerous servant. It is true that, compared with those which have accompanied the introduction and use of steam and gas, the number of accidents in the use of electrical apparatus is very small. But in this age comparative rates will not be accepted as answers; the people have a right to demand that devices for public safety keep pace with development in other directions. The discussions of Professor Thomson and Messrs. Haskins and Harber will present this currrent topic in its various phases. I trust that each speaker will enforce the importance of good construction and maintenance on the part of producers, and proper inspection on the part of the municipality.

It is hoped that the Committee on "Underground Conduits and Conductors" will be able to report some facts regarding the actual

operations of high-pressure currents underground. Thus far, discussion of this topic abounds in theory and speculation, but contains little experience.

During the past 12 months, there has not only been a greatly increasing activity in the electrical industries abroad, but many millions of foreign money have been invested in the electrical properties of America. It is worthy of note that our brethren in Great Britain have set the example of adjusting differences amicably instead of carrying litigation to the court of last resort. Such a policy in America would not only have saved hundreds of thousands of dollars now charged to profit and loss, but would have greatly enhanced the value of electrical securities.

The past year has furnished instances in which the value of local electrical properties has been greatly depreciated through the invasion of territory already fully occupied. This policy is short-sighted. Prices in most cities are fair and just, both to consumer and producer. To depreciate them will not only ruin the business of pioneer companies who have invested large sums and borne the brunt of introducing a new and valuable industry, but cannot fail to result in great loss to the invader.

Although electric lighting in this country has seemed to receive a check, a look ahead would not be discouraging. The law that "action and reaction are equal and in opposite directions" applies not only to mechanics, but to public opinion. As America is the birth-place of the commercially successful electric light, and as Americans are the foremost people of the world to recognize improvements, we may well believe that with proper attention on our part to our duties to the public, the present popular and largely sensational agitation against us will give place to a feeling of confidence. In the meantime, let the outcry teach its proper lesson to all engaged in the electrical business. (Applause.)

Secretary Garratt then called the roll of the Association, and the responses indicated the presence of somewhat more than one hundred members.

Secretary Garratt presented his report as follows:

REPORT OF THE TREASURER AND SECRETARY DEC. 31, 1889.

Balance from account rendered July 31, 1889, at Niagara Falls	$1,096.93
Dues from 51 members	1,020.00
	$2,116.93
Expenditures as per accompanying vouchers, numbered 87 to 112 inclusive	$1,506.66
Balance cash on hand Dec. 31, 1889	610.17
	$2,116.93
The indebtedness of the Association is an unpaid bill of	259.60

The above expenditure of $1,507.76 for the six months ending Dec. 31, 1889, may be classified as follows:

Postage	48.52
Stationery and printing	143.90
Official stenographer	85.37
Rent of office	50.00
Advertising	46.99
National Committee on State and Municipal Legislation	98.65
Salary of treasurer and secretary	999.96
Expenses not specified above	33.37
	$1,506.76
The total receipts for the year 1889 have been, including the balance from the previous account	$5,845.55
Total expenses for year of 1889	5,235.38
Balance cash on hand Dec. 31, 1889	610.17
	$5,845.55

The expenditures of the year 1889 may be classified as follows:

Old bills incurred previous to 1889	$1,483.82
Salary of secretary and treasurer, 12 months	1,999.92
Clerk hire	40.00
Postage	176 48
Printing and stationery	712.19
Official stenographic reports	246.62
Rent of office	207.50
Advertising in electrical journals	101.99
National Committee on State and Municipal Legislation	98.65
Not otherwise specified above	168.21
	$5,235.38
The net income for 1889 was	$5,545.82
The running expenses for 1889 were	3,751.56
Excess of net income over running expenses	1,794.26
	$5,545.82

Membership.

Total number of members July 31, 1889	251
Members added between July 31 and Dec. 31, 1889	21
Total	272
Members resigned between July 31 and Dec. 31, 1889	13
Making total membership Dec. 31, 1889	259

It will be noticed that the above reports closed Dec. 31, 1889, which is the end of the fiscal year.

On motion the secretary's report was accepted.

Secretary Garratt read communications from the following: A communication from the Commercial Club of Kansas city tendering the convention a reception. Accepted with a vote of thanks.

The secretary also read a communication from W. H. Breithaupt, president of the Engineers' Club, of Kansas City, tendering the privileges of the club room to the association during the convention.

Also a communication from J. H. Veitch, General Agent of the Chicago, Milwaukee & St. Paul Railway, extending and invitation to the members of the association to visit the great health resort of Missouri, Excelsior Springs, and offering a special train for that purpose on Wednesday, the 12th, at any hour which might suit the convenience of the association. A communication from Howard M. Holden, president of the Excelsior Springs Company, extending an invitation to the same effect, was also read.

The secretary also read a communication from William Wiley Smith, secretary and superintendent of the Missouri and Kansas Telephone Company, of Kansas City, extending congratulations to the association and offering telephonic facilities between the halls and the central office, and also extending to the delegates an invitation to visit the central office of the Telephone Company, in which, as was stated, nearly twenty-six hundred wires were handled in one room and over thirty-two thousand calls per day were made.

The invitations contained in the above communications were on motion accepted with thanks. The invitation to visit the National Military Home for Disabled Volunteer Soldiers at Leavenworth, and the offer by Mr. G. W. Warder of a reception at the Warder Grand Opera House were both referred to the executive committee.

Secretary Garratt then announced a meeting of members from Missouri for the purpose of forming a State Association, and gave other notices.

On motion of Mr. F. E. Degenhardt, the Chair was authorized to appoint a committee to draft suitable resolutions concerning the death of Messrs. C. McIntire and M. W. Goodyear, late members of the Association.

The convention then adjourned until 9:30 A. M. next day.

SECOND DAY'S PROCEEDINGS.

Morning Session.

The convention was called to order in Music Hall at 9:40 A. M., President Weeks in the chair.

Secretary Garratt read the communication from the Metropolitan Street Railway Company offering the free use of the cars to the members, and one from the Missouri State Association of Architects then in session in Kansas City, inviting the members to inspect the exhibit of architectural drawings. Both were accepted with thanks by the association.

The secretary then read the following telegram:

NEW YORK, Feb. 11, 1890.

E. R. Weeks, President National Electric Light Association, Kansas City, Mo.:

"Sorry to be debarred from attending the convention. The Association has our heartiest good wishes and will always have our best endeavor. May its deliberations be marked by Western breadth and Southern generosity, and may it grow as fast as Kansas City. Signed, T. C. Martin and Joseph Wetzler, Editors THE ELECTRICAL WORLD.

Mr. G. M. Phelps then presented the

REPORT OF THE COMMITTEE ON THE ABOLITION OF CUSTOM'S DUTY ON COPPER.

The committee appointed at the last meeting of the National Electric Light Association to petition the proper committee of Congress for the abolition of duty on copper, appeared at Washington January 16, through Mr. Phelps, who presented the following petition to the Committee on Ways and Means with the subjoining addresss:

Petition to the Honorable Committee on Ways and Means, House of Representatives, U. S. A.:

The subscribers were appointed a committee to petition your honorable body for the abolition of duty on copper, ingot, plat bars, rod and wire. We represent the National Electric Light Association, a body composed of representatives of electric lighting companies throughout the United States, and also of manufacturers of and dealers in electric lighting apparatus and supplies.

The resolution appointing this committee was passed without a dissenting voice. We, therefore, have the honor to present this petition, earnestly requesting that the action asked to be taken as a measure which will be approved by the great body of users and manufacturers of copper.

[Signed] CHARLER A. BROWN,
GEORGE M. PHELPS,
J. F. MORRISON.

The National Electric Light Association consists of corporations, firms and individuals owning and operating stations and plants for the distribution of light and power by electricity.

At the time of the last convention of the association, August 6, 1889, the capital then invested in the industries above named was estimated, from the statistics collected by the secretary of the association, to be not less than $275,000,000. This sum represented mainly electrical apparatus and electric conductors for the supply of 238,000 arc lamps, and 2,700,000 incandescent lamps, in all which apparatus and conductors copper is an indispensable and chief material. In the total cost of electric plant for light and power distribution, it is estimated, by competent experts, that from one-fourth to one-third is expended in copper. The foregoing figures and statements sufficiently indicate the magnitude of the interest of electric light and power companies in the price of copper.

In the opinion of the petitioners the proposed abolition of the copper tariff does not touch the question of protection to American industry. The duty on copper appears to be wholly superfluous as a protection to American producers of that metal. The United States not only produces more copper than it consumes, and consequently exports that metal, but it possesses the richest and most easily worked copper mines in the world, and its mining companies produce the metal and put it in the market at a lower cost than is possible to the Spanish or Chilian miners. Obviously the American producers of copper require no duty to protect their domestic market, and their exports of copper furnish sufficient evidence of their ability to meet competition in foreign markets.

The existing duty is of no appreciable value to the National Treasury, because copper is not imported in any considerable quantity. As a source of National revenue the copper tariff is practically useless, and the returns from it could not be increased materially under the conditions of production throughout the world by any modification of the rate of duty, if the government needed increased revenue, which it confessedly does not.

It would appear, therefore, that the duty on copper can only be efficient in enabling the mining companies and dealers in copper to establish and maintain excessive prices through combination for that purpose. It is believed that the United States duty of four cents per pound was a considerable factor in the operations of the syndicate established in France in the autumn of 1887, and which syndicate, aided by its agreements and contracts with copper mining companies in this country, succeeded in controlling the copper production and markets of the world for more than a year, doubling, for a considerable period, in London and New York, the price existing just previous to the beginning of its operations. This was effected, moreover, in the face of an abundant supply of the metal. For some months after the breakdown of the French speculation the American companies maintained the price in this country considerably in excess of that of European markets.

Touching the relation of the duty on copper to combinations for maintaining excessive prices, the following quotation is subjoined:

Extracts from editorial in New York *Tribune*, May 15, 1889.

"The mine owners have publicly stated that they are able to produce more than all the copper this country consumes, and a large part of it at a cost not exceeding six cents per pound, and that they propose to the French bankers, who hold an enormous unsold stock, to fix the selling price at about thirteen cents per pound—more than double the cost. Nothing need be said about the right of the producer to get a profit of more than 100 per cent. on his copper, provided he is not a beneficiary of a national policy intended to protect and encourage American productions. But the mine owners are beneficiaries of that policy, and owe to the public a certain consideration and service in return. If they enter into a combination for the benefit of foreign speculators and bankers against the interests of American producers, the duty on copper may not last long. . . . There will, in all probability, be a revision of the tariff next winter. The party in power being anxious to defend all industries that need and merit defense, will, for that very reason, be more strongly pressed to cut off duties where no defense appears to be needed, or where it seems to be deserved. Combinations of speculators to corner the markets of the world are not highly popular, and will not appear to members of Congress to merit particularly favorable consideration. Under such circumstances the demand for a removal of all duties on copper ore, pig and bars, will be difficult to resist. It is safe to say that, had the Mills bill proposed no change more unpopular or unobjectionable than that, its public support would have been incomparably greater."

In short, and to recapitulate, in the opinion of the National Electric Light Association the duty on copper, being useless for revenue and unnecessary for protection, should not be suffered to remain on the statute books of the United States, since its only remaining function is to serve as an ally to the promoters of combinations for putting up prices, a process to which the government should not lend its assistance.

The committee have circulated an auxiliary petition in support of the petition presented in behalf of the Association. It has been intended to solicit the signatures of all companies, firms or individuals engaged in electrical industry, and to offer opportunity for signing to all other persons accessible to the committee who are in sympathy with the proposed measure.

On Feb. 8, 440 signatures to such auxiliary petitions were forwarded to the Committee on Ways and Means of the House of Representatives.

Your committee are still engaged in circulating copies of the auxiliary petition, and hope to collect several hundred more signatures.

The committee would earnestly request members of the Association or others inclined to sign the petition, who have not received a copy, to address either member of the committee, viz: Chas. A. Brown, 227 S. Clinton street, Chicago; George T. Phelps, 150 Broadway, New York, or J. F. Morrison, 15 South street, Baltimore.

I wish to suggest further that members who feel deeply interested in this matter would contribute to the success of the petition by addressing communications to their several representatives in the National Congress. It is somewhat problematical, I think, whether any discussion of the subject of revenue at all will be permitted to take place on the floors of Congress this session. But, if such a discussion can be brought about there, it is the opinion of your committee that the success of their petition is exceedingly probable. There is practically nothing to be said in favor of retaining the duty on copper. I have not heard a word in defense of it. The only persons who have been at all disinclined to sign the petition have been those who have said, substantially, "Yes, it is all right; the duty on copper ought to go, but we make something else, and our friends make something else that are protected by tariff duties, and we do not want the question stirred up." We feel that the greatest difficulty will be in getting the thing "stirred up." If it can be "stirred up" and brought to the attention of the National Congress on the floors of the House of Representatives, it is my individual opinion and I think the belief of the rest of the committee, that the copper tariff will not last long. All those who are in sympathy with the measure will contribute to its successful issue by addressing their members in Congress, or any Congressmen or Senators to whom they have access in any way. (Applause.) I ought to say I am but one member of the committee present. Mr. Brown, the chairman, is unable to attend, and Mr. Morrison, we all know, is unfortunately prevented from being here. I have made out this report after conference with Mr. Brown, but have not been able to see Mr. Morrison.

I ought to say further, perhaps, as a matter of record, that there was no appropriation made for the work of this committee. Your committee have expended a considerable sum of money, and a great deal for printing and postage was required. In due time, when we are through with our work, we may present for the information of the association a record of this matter.

President WEEKS: That would be eminently proper and will be properly received by the association, I think. Gentlemen, this subject is a matter of great moment. Aside from its national—I might say international—interest, it is a matter that comes right home to every one engaged in the electrical business, and it illustrates very nicely the community of interests that prevails; and we should all appreciate and understand that whatever affects the manufacturer of electrical apparatus affects the user of that apparatus, and what affects the user of apparatus must necessarily come right down to the user of the product of that apparatus—the general public. I repeat, gentlemen, that this is a very important question. The report is now before you; what is your pleasure?

Mr. DE CAMP: I move the report be received and the committee continued. Seconded. Carried.

The secretary then read the following letter as the

REPORT OF THE COMMITTEE ON UNDERGROUND CONDUITS AND CONDUCTORS.

NEW YORK, Feb. 7, 1890.

E. R. Weeks, Esq., President:

DEAR SIR: As Chairman of the Underground Committee, I would report that it has not been possible to obtain a quorum at any of the meetings that have been called. Several of the committee are not members of the Association, and have sent in their resignation as members of the committee. Others live at such a distance as to render it impossible for them to attend any meetings, and some of the remainder do not respond to communications. Under these circumstances (as the subject is a very important one), it is requested that the convention appoint a committee with the idea of bringing some of the "new blood" of the association into this active and interesting field. The experience to be gathered from the operation of such wires as have been buried in New York City (most which have proved failures up to the present time) can be easily gathered in time to report to the next meeting of the Association.

EUGENE T. LYNCH, JR., *for Committee.*

Mr. DE CAMP moved that the report of the committee be received and the committee discharged. Seconded. Carried.

Mr. MASON: Mr. President, I move, in accordance with the recommendation of the committee, whose report we have just received, that the Chair appoint the committee which is referred to in the report. I would like to have the association placed on record as authorizing the appointment of the committee, and leave its membership open for further consideration. Seconded. Carried.

Mr. T. CARPENTER SMITH then read

REPORT OF COMMITTEE ON STANDARDIZING OF POTENTIALS.

In behalf of the committee appointed at your last meeting, for the standardizing of potentials for electrical apparatus for street railway systems I would present to the association the following report:

It was deemed advisable by the members of the committee to send out a circular to all railway companies operating their systems of car lines by electricity, notifying them of the appointment of this commitee, and asking not only their co-operation, but also drawing their attention to a number of questions that we desired they should reply to. Acting upon this conclusion the committee drew up and mailed to all these companies the following circular.

Gentlemen: At the semi-annual meeting of the National Electric Light Association, held at Niagara Falls, on Aug. 6, the following resolution was offered and adopted:

"WHEREAS, It is the belief of the members of this association that the electric motor service upon street railways will require a service of electric current for the motor that will be reliable and constant, and that the various electric light stations are capable of generating and distributing such current,

"RESOLVED, That a committee of three be appointed by the president, who shall endeavor to make such arrangements, with the manufacturing companies, that they should adopt some standard potential to be used upon the various railways. The committee also to collect such data regarding the supply of current to railways as may be deemed of interest to the association.

The President appointed Messrs. Eugene T. Lynch, Jr., of New York; T. Carpenter Smith, of Philadelphia, and Marsden J. Perry, of Providence, as members of that committee.

It has been thought advisable to collect and compile the opinions and experiences of such street railways that have adopted electricity as a motive power. Will you, therefore, kindly fill out and answer such of the following questions as you feel you can answer?

1. What system do you use?
2. What proportion of your cars are equipped with motors?
3. Do you generate your own electrical power, or are you supplied by an electric light station?
4. What proportion does your greatest average horse power in use bear to the total horse power of engines and boilers which you have installed?
5. What is the voltage or pressure of your generators?
6. Is there any other railroad in your town using an electric system? If so, what system do they use, and do you know the pressure at which they run?

We have received replies from 85 per cent. of all the electric street railway companies. They have one and all showed every disposition to give us full reports upon the questions that we have asked them, and have stated that they would afford us every facility that lay in their power, and that they desired us to convey to the National Electric Light Association their hearty indorsement this plan.

We think it advisable to divide our report into three parts. First: A statement of the conditions under which the various railways have been operating up to the present time. Second: The report of your committee upon the arrangements made with the manufacturing companies. Third: A set of statistics carefully compiled from reports made by some of the most prominent central stations showing the advantages that will accrue to the investor by the combined operation of the electric light and electric street railway interests working under the agreements that have been promised to your committee.

First. Under the first question we do not desire to give any statements regarding the number of railways that may be operated by any particular company beyond the fact that fully 90 per cent. of all the railways now in successful operation are operated under the systems controlled by the Thomson-Houston and Sprague companies.

In answer to our second question we find that at least three fourths of the railways have equipped all their cars with motors, and that the sizes of the motors upon the cars vary from 7½ to 15 h. p.

Only nine electric light companies have been brave enough to agree to supply the street railway companies with their power, although in nearly every case where the railway was in operation there was at least one central station company who could have contracted to supply the necessary current.

The answers to the fourth question give to your committee the information that will prove of value to the association.

In all railways operating over fifteen cars only one-third of the total horse power with which the plant has been equipped has ever been called for at one time. On all roads operating between 5 and 15 cars the greatest average load has not reached 50 per. cent of the total horse power, and upon smaller roads the average load has varied from 50 to 80 per cent. of the total horse power. All roads that have met with heavy grades have raised the average very considerably.

We find that the potential varies from 220 to 800 volts; the greater number of companies, however, report using a potential between 450 and 550 volts.

Our sixth question was directed partly as a check upon our being furnished correct information upon the names and locality of the various roads, but mainly to ascertain whether an opportunity was afforded to operate several street railway companies from the same central station plant.

The answers to this have been many and curious. In some cases they have disowned all knowledge of the existence of any other company, and in nearly every case, they seem to be imbued with the rivalry quarrels or misunderstandings of the various patent or manufacturing companies whose aparatus they are using. They agree, however, that they would be willing to use the power supplied to them from some central station, provided, that they be assured by the company who equipped their road that the potential or quantity of current used would not be detrimental to their apparatus.

Copies of the circulars, together with a letter explaining more fully the plan suggested by your committee, were sent to all the manufacturing companies. They were also requested to furnish the committee with a list of the particular railways operating under their systems. After much correspondence and many personal interviews your committee would announce that they have written authority from both the Thomson-Houston and Sprague Street Railway companies to make the statement on behalf of their particular companies that they will agree hereafter to use a standard potential of 500 volts upon all electric street railway equipments that do not require any special apparatus for their successful operation.

In recommending electric light companies to add to their regular central station business the business of furnishing power to street railroads, we wish it fully understood that we do not base any hopes of profits to be made upon the old time idea that the same machinery can be used for furnishing light at night and power in the day time. This specious argument has led many companies into large expenditures for motors, etc., and they have discovered later that it costs very nearly twice as much money to run the same machinery night and day, as to run it at night alone; and that it pays better in the long run to have an entirely different class of apparatus to produce light and power.

The true direction from which returns may be expected in the massing in large stations of the generation of electricity for both light and power, is found in the fact that an electric light station, to be sure of continuous running, requires a reserve of from 15 to 25 per cent. of its average load in boilers, engines and dynamos; the per cent. being larger in small stations and diminishing as the station increases in size.

This same reserve in capacity is required for the power station, but on street car work in most of the stations hitherto installed this percentage runs very much higher, being from 50 to 80 per cent. It will be manifest to every one on a little reflection that a station which is generating current for two street cars is compelled to have power enough provided to allow of the throwing on at the same instant of both these cars; that is to say, generating capacity of fully twice the average amount of power, or 100 per cent. reserve. As more cars are added the chance of any particular number being thrown on at one time becomes less and less, until, in a station operating 200 cars, a single spare generator to take the place of any one which might be disabled would probably be all the reserve needed. This feature is shown very clearly in the running of the ordinary three-wire electric station, where, when the total load is light, a few lights thrown off or on either side will make a big difference in the balance, but as the total load increases, the number of lamps thrown off or on either side at any one instant is so small a perceutage of the total load that the station needs practically no balancing. Now if in any one station supplying electricity for all purposes in a town, we have, say 25 per cent. reserve in boilers, and 25 per cent. reserve in steam engines in excess of the average load, we shall only require to place 25 per cent. reserve each, on electric light dynamos and power generators to have practically the same result as though we had two complete separate stations for electric light and for electric power, each with its proper reserve of 25 per cent. extra in engines and boilers and dynamos.

Another important point to be considered, and one well worthy of consideration by electric light stations, is, that in many cases they could furnish this current delivered at the walls of their stations; that is, the car company will take care of its overhead lines and connections, and the electric light companies will be paid a rental simply for the electricity delivered to the car companies' lines.

As an instance of what may be done in increasing the out-put of a station, without a corresponding increase in expenses, we quote the case of a small station, which, as nearly as can be determined from results, shows the following condition of affairs.

The station increased its business in 1889 over 1888 23 per cent., and in the same time the total expenses, including the extra line work and distribution expenses, amounted to 10 per cent., which 10 per cent. meant 10 per cent. increase in running expenses, and 10 per cent. in fixed expenses. The company contemplates a further increase of 27 per cent. on the same basis; this increase, however, being for power furnished alone, without any line work involved; the most careful calculation shows that this will only increase the present running expenses 10 per cent. without increasing the fixed charges at all.

In 1888 the proportion of fixed charges to running expenses was 25 per cent. and 75 per cent., respectively, of the total expenses. In 1889, this same proportion held good, each having been increased 10 per cent., as above stated, and the total expenses having increased the same amount. The further expected increase, being 10 per cent. of 75 per cent., will mean an increase in the total expenses in 1890 over 1888 of 17½ per cent., while in the same time the total output of the station, and consequent gross receipts will have increased 50 per cent.

These figures are all taken from the case of a small station with a total output of some 350 h. p., and a fresh increase in this station above this point) will result in an entirely different condition of affairs, so that a readjustment will take place in the proportion of fixed expenses and running expenses. We therefore present the report of another station which is operating 1,200 h. p., in which the total operating expenses are divided into 80 per cent, running and 20 per cent. fixed. On increasing the station to an output of 1,800 h. p., the increase to be entirely in the furnishing of power, the increase on total operating expenses would be about 14 per cent., and the ratios of fixed and running expenses would be 15 per cent. and 85 per cent., respectively.

The report of another large central station, operating at least 2,500 h. p., has been divided somewhat differently. The fixed charges are 14 per cent. of the total expenditures. All labor and pay rolls amount to 41 per cent., and all material, such as coal, carbons, lamps, wire, oil, etc., amount to 45 per cent.

Taking in account all their past calculations and experiences, they are very confident that they can operate at least double their present output, be it light or power, at one-fifth more for fixed charges, one-third more for all labor and pay rolls, and, say, three-fourths more to their present material item, making a total additional charge of, say 50 per cent., upon their present expenditures and giving them in return at least double the gross income. As stated before it will not be found advisable to calculate upon using the same engine, boiler and dynamo power for the double service, for lighting at night and power during the day time except, of course, in some few isolated cases.

The great saving for the central station company lies in the reducing in labor and fixed charges, and also that the reserve power for one will suffice for the other. Your committee feel that a great step has been taken in the right direction in securing the endorsement and co-operation of the largest and leading companies, and they would suggest to the association that some measures be taken to secure from the stationary motor companies the adoption of some standard potentials for their use upon constant potential circuits.

E. T. LYNCH, JR., Chairman.

At the suggestion of Mr. Mason the discussion of the paper was postponed till after the reading of Mr. F. J. Sprague's paper on Electricity as Applied to Street Railways.

Mr. H. P. ALEXANDER then read the following

REPORT OF THE COMMITTEE ON HARMONIZING THE INSURANCE AND ELECTRIC LIGHTING INTERESTS.

The Committee on Harmonizing the Insurance and Electric Lighting Interests was continued at your session, held at Niagara Falls last August, and requested to confer once more with the fire underwriters regarding the best means of preventing fires from electricity, and to try and bring about a reduction of insurance on the buildings lighted by electricity. The committee has had many sessions, and a great deal of correspondence with fire underwriters, and can only reiterate the recommendation made at the last meeting of this convention regarding the desirability of examining and licensing men employed in electric lighting, and would further recommend all electric light companies to contribute towards the remuneration of several expert electrical engineers in different parts of the United States, who should instruct special agents or inspectors of insurance companies in the necessary knowledge to discern between good and bad electrical installation.

The committee thinks that special agents and inspectors of insurance companies ought to qualify themselves in inspecting electrical installation, as far as fire is concerned, the same as they qualify themselves in inspecting other appliances put up in buildings, and judge of their relation to fire hazards. The committee realize that as long as inspectors are employed at the expense of the electric light companies, underwriters will take no pains to acquire for themselves the necessary knowledge to inspect such risks.

The committee would, therefore, recommend to electric lighting companies the appointment of an instructor to special agents for a period not exceeding one year, feeling certain within that time every special agent and inspector of fire risks could acquire all the necessary knowledge to enable him to judge of electrical installation as far as it applies to fire risks. The committee has communicated these its ideas to underwriters' associations and insurance boards, but must confess that it has not met with the favorable responses to this proposition that it anticipated; however, the insurance interests seem to be willing to take some steps to bring about the harmonious relations so much desired.

Your committee was also instructed to report upon the advisability and feasibility of a mutual insurance company for insuring central stations. A plan was proposed by Mr. S. E. Barton and Capt. William Brophy, both of them well known to you, for the establishment of such a mutual insurance company, a prospectus of which is filed herewith,* and has been forwarded to the members of this association.

The committee after carefully considering the plan of operation as prepared by these gentlemen, has unanimously indorsed their ideas, as have a great many central station men of note, members of this association, as well as of the Association of Edison Illuminating companies. The plan proposed, will not only reduce the cost of insurance, but will aid in perfecting the construction of central stations; and by frequent inspections will aid the managers of such stations in the knowledge of modern appliances.

Your committee would be glad to have this matter freely discussed here to-day to see if the project is not worthy of the official indorsement of the National Electric Light Association.

Mr. GEO. CUTTER, of Chicago: I propose to speak to you simply in an off-hand manner. I feel free to do so, as I have almost the courage to put myself before you as the mouthpiece of the electric light men in the West on this question. We have looked East for information as to harmonizing electric light and insurance interests. We feel to-day that this is necessary, and that a great deal of good will be derived, both by the insurance interests and the electric light interests, from action of this kind. A thing of great importance to us in the West is to have this movement pushed rapidly forward, so that our electrical engineers will know what is best for the best class of work. We have constantly cropping up before us people who want their work done according to insurance rules. We have no insurance rules. I should rather say we have a variety; but one engineer works upon one line of insurance rules, and another engineer follows another line. For instance, a short time ago a movement was started in Lake View to compel putting wires underground. As a sort of compromise, it was published in the papers that an arrangement had been made by which the wires were to go under the street and then over the housetops. In some insurance rules special mention is made that the wires should be kept away from the buildings, and this appears to us as all-important.

I feel that if a committee composed of electric light men and insurance men would work together to outline a national set of rules for electric light installations all over the country, we would all be benefited by it. The necessities of the case and the uncertainty among purchasers of electric light plants, on account of the contradictory statements made by salesmen, has created a demand for consulting engineers in the West, and this demand is being filled in a very unsatisfactory manner. They are opening offices in different places and traveling about as consulting engineers, and among them are many who have no practical experience whatever with regard to electric light installations. They drift around and talk with one superintendent and another, and in that way get a little information.

I feel that in connection with this committee, in the same line of thought which is advanced in the report, a superintendent of installation should pass an examination. This would sift out these so-called electrical engineers, whose knowledge extends perhaps to the putting up of a vibrating bell somewhere, and who know absolutely nothing about electric light plants. The inspection of an electric light plant requires experience in installing the same and in handling the apparatus, and that would be one point to be taken into consideration by a joint committee working in harmony. Now, the thought that I want to express, is as to the value of a standing committee composed of electric light and insurance people working in harmony to keep pace with the growth of our industry, so that we may know the best method of installing the apparatus.

It seems to me the question divides itself practically into two parts—one, the insurance of the central station, in which the situation becomes simply that of buyer and seller; second, insurance outside of the central station. There our interests are identical. The electric light companies want that work well done, so that they will have no unnecessary expense and so that the public will feel that they will have no accidents. The insurance people also want the same thing. Their interests are identical, and it is in this line particularly that a committee consisting of members of both branches, working in harmony, would accomplish a great good. Therefore the consideration of the question could be left to a committee appointed by the National Electric Light Association and representatives of the insurance companies. In all probability that committee would consist of members in the different sections of the country, so that the tendency of sentiment in each section would be represented in that committee. Such a committee would soon get a thorough knowledge of the various rules for installation throughout the country among the electric light people, the underwriters and the architects, and this, together with the knowledge of the members of the committee, would bring about the adoption of a set of uniform rules which would control our installations all over the country. In this way the people of the smaller towns of the country would have the the advantage of knowing what the insurance rules were, and would have the means of knowing what proper installation is. The result would be that the public would finally gain that confidence in electric lighting which it deserves, and the purchaser of an electric light apparatus would have information as to what good installation is. Therefore, this committee which we appoint now should work in connection with the insurance people, looking to the establishment, either of a standing committee or some board which would be a body to whom should be referred important questions for final reference in relation to installation.

I think such a body as that would ultimately become a great power in the land, and with careful work would make our business known to the people and do away with the scare which exists to-day, and would also check the growing tendency among politicians to interfere with our work. They are finding that the electric lighting business is profitable, and the more they find that out the more will they interfere with us and our rules, unless we have a power derived from an influence obtained through public opinion, which will check this interference by politicians, that will be disastrous to our industry unless it is checked. (Applause.)

MR. T. CARPENTER SMITH: I am very much in favor of such a committee as has been recommended. I represent a company in what is usually called a pretty slow-going town; but, notwithstanding that, we have made progress there. In Philadelphia, we have an insurance inspector, who has taken a very original course, and absolutely refuses to lay down any rule for wiring, on the ground that just as soon as an absolute rule is made, just so soon will be found the means to evade it. He has also been opposed very much to the licensing of wire men, on the ground that while you may very easily control by a license system the extent of a man's knowledge, you cannot control his trustworthiness. We have men who are doing wiring as contractors in Philadelphia who can pass about any examination that can be devised; yet those men will deliberately splice underwriters' wire on the inside of a building and splice waterproof wire on the end of

* See THE ELECTRICAL WORLD, Feb. 1st, 1890.

it where it comes out, and they will even wrap tin foil around it so that it will look as if it was soldered. (Laughter.) Now, no licensing system will control men like that. These are the points which I think the committee should take very carefully into consideration when they try to draw up any set of rules.

After all, it comes down a great deal more to common sense than electrical knowledge in doing wiring, especially about central stations. At one time, in the early history of the art, underwriters' wire was cleated to the floor and run through a house without any rubber around it, and it was thought that was good enough. Then we got a great scare about the water-proof business, and everybody wanted rubber-covered wires. Then we got to running rubber covered wire on glass insulators, and thought that was just the thing; but a day came when we found that the rubber cover carried the flame and was more dangerous than the electricity. Now we have got down to porcelain and glass insulators. We have begun to find that our old, despised friend, the underwriters, is not a bad thing to go through a building, because, while it may get wet, it will not carry the flame. I think ninety per cent. of the cases of scare from fire from this cause occurring in Philadelphia come from the flexible cord which has been handled until all the strands are broken, except one or two, which are unable to carry off all the current, and all at once a little blaze is discovered in the ceiling. When this happens people run out of the room, and before anything is done to check it, the fire gets considerable headway and makes trouble.

Now, we are going through a little circus in Philadelphia with regard to underwriters' inspection, and a scheme has been formulated which has the germs of a very good system in it. The electric light companies cannot compel a customer to have his building wired properly. If they attempt to do anything of that kind, the customer says, "I will get some other company to do this;" and after the work has been once done in his building, no matter how dauderous it may be, you cannot get him to change it. It is questionable also whether he cannot compel you by law to serve him with current. There are so many advantages in coming under the law of common carriers that I think it will be found on examination to outweigh the disadvantages, if we can only get some way of compelling customers to put the wiring in their buildings in a safe condition.

There is no question but that the insurance people can compel a customer to do almost anything. The worst class of customer we have to deal with is the very one who is scared the most about having insurance taken off his building, and a mere suggestion or hint from his insurance company that it will not continue his policy, will bring him to terms in a moment. I think, therefore, that we should attempt to throw the onus of all compulsory work on the insurance companies. It does not affect their business a particle. They can put a man's premium up two per cent., and it makes no difference; they can get his insurance just the same, because they are a strong body, and when they have agreed to do a certain thing, they do it, and no man can afford not to have his place insured.

We are talking of an arrangement which I think will go through, whereby the electric light companies are to pay an annual sum to the insurance companies for every arc light installed, and for every incandescent light installed. This is to apply to the maintenance of a staff of skilled inspectors, who shall not merely inspect all new work, but shall periodically inspect all work already installed, so that any changes may be examined and any man who is found sticking 50-candle lamps on a wire that was meant for 10, can be detected; and this will be stopped by a power that is greater than the power of the electric light men—the threat of withdrawing their insurance. On the other hand, the incandescent men will also compel the owners of all incandescent lighting plants and arc lighting plants to pay them that higher rental,

The matter really comes down to this: That a certain sum has to be paid every year for skilled supervision and inspection of new work and work already installed, the costs of this new inspection to be divided pro rata among every user of incandescent and arc lamps, the only difference being in the case of people who are supplied from central stations, that the central station shall bear that expense. Now, as a central station man, I think that the cost of such a system would be ten times repaid to electric lighting companies every year, in the satisfaction they would have of knowing that somebody else was responsible for the condition of their numerous wires. An electric lighting company has enough to do to get the current out on the line and make money out of it, without having to lie awake nights worrying over the condition of the wires in the different buildings all over town. We must remember that the electric lighting business is a lighting business; and if you make money in it, you do so, not because the lighting is done by electricity—a great many seem to think that because a thing is electric there is millions in it—but because electric lighting is a very good business. Every business must be run in a business-like way—that is the experience of the past, and is what we must do in the future; run every business in a business-like way or the business would never pay. Now the gas companies have got to a certain condition after 40 or 50 years of hard experience. They did not get their experience from having somebody sit down and figure it out for them. They started, just as we have, by piping people's buildings and doing everything of that kind. Gradually they began to cut off these little luxuries, and now they have got down to simply delivering gas at the customers' premises. They put their meters in and are responsible for them, and beyond that they are not responsible; and the electric lighting companies must get there too just as quickly as possible. (Applause).

Mr. M. J. Francisco, Rutland, Vt.: Mr. Smith has overlooked the fact that in New England we have an association of the very kind that he desires in Philadelphia. It is known as the New England Electric Exchange, and also as the New England Insurance Exchange. The two are working together as one body, practically; that is, the orders of one go into the other and there are enforced by one organization. Now, then, in regard to the wiring business. If they have the proper men in Philadelphia to examine the wiring, I do not think they will put much tinfoil in place of solder. At least, if they tried that with an inspector like Captain Brophy they would not find that the plan would work. He is the inspector for New England. If you will find a man who will use tinfoil and have it pass Captain Brophy, I say let it go; the line will be all right. In New England they license these men. One of the conditions to be considered is the moral character of the man. He must have a record; he must have a standing, or else he cannot procure a license to do this business. And another thing which is a very important item in regard to the wiring of houses and wiring of buildings is that they must be wired in accordance with the rules of the Insurance Exchange. After they are wired, the electric lighting company invites the Exchange to send their inspector there to make an inspection of these wires. If they are in accordance with the rules of the Exchange, as well as of the company, they are passed; if they are not, they must come out; they cannot use them; they have got to take them out and put them in as they should be. The moment they refuse to do that, not only have they got the electric lighting company's order to discontinue the current, but they have the Insurance Exchange to deal with, and they cancel every policy on that property. There are two bodies back of these rules to enforce them. That is the basis on which all this business should be carried out through the whole United States. These organization of exchanges and insurance companies should be effected throughout the entire United States. That was the plan discussed at Niagara Falls, and that is one of the objects of this committee in making this arrangement.

Now, one word in regard to this insuranee business. I have been engaged in the insurance business for about 25 years, and I have had a good deal of difficulty in getting the companies to believe that electric lighting plants were good risks. In the discussion of this exchange business, the matter of the mutual companies has been brought up. We will, of course, run on a stock basis. I have always been a little skeptical, as I have got left once or twice on this mutual business. But in this present proposal, the one that has been inaugurated here at this association and practically indorsed, we have an arrangement, with the association practically at the head of it, with two men who have had as long and as varied experience, probably, as any man in the United States. When you put the men with their experience and knowledge at the head of an association of this kind, to effect and carry out these plans, I consider that we have got a plan that we can all heartily indorse, and one which will give us insurance at its actual cost, and in a shape whereby we can cover the property, and not have, as a large number of stations are now, our property without any protection whatever. In the last year I have received a hundred and fifty, if not two hundred, letters in reference to this insurance matter, asking, "Why cannot we get our property insured, and how can we arrange these stations so we can insure them? Can it be so arranged?" Well, of course it can be so arranged, but under present arrangements there is no inspection. The new companies being organized do not know what to do; they are going to put in a station, and of course they do not understand the rules of the insurance companies, and they do not understand how to arrange these stations, and they may proceed in such way as to destroy their insurance at once. Now with a proper inspector, he goes there and sees these plans and points out the defects to them and says to them, "Now here, you fix that matter there in proper shape, and you are all right; you can get your insurance without difficulty; it will come all right." And that is just the plan, as I understand it, of this mutual combination that is being organized. They propose to have an inspector who will go to your station, examine it, and if he finds anything that is improper, or out of the way he will explain to you what wants to be fixed, and you fix it. You can then procure insurance at a rate which you can live by. I have had letters, numbers of them, from parties who said "the insurance companies are charging us 5 per cent. on our station." Well, of course there is some reason for that, as companies do not do such a thing unless there is some reason; but in many instances it is because the companies do not understand the rules and principles to apply in arranging the stations to properly protect insurance companies. In many instances that is the trouble; and, of course, the insurance companies in a large number of cases, have inspectors of insurance risks, who know little or nothing about the elecrical part of it. They are thoroughly ignorant in a large number of cases of the electrical part of the business and the danger of an electrical current. Now in this case, as I understand it, this inspector is to be a man who thoroughly understands the electrical part, and can explain all of those dangers that every station has to meet, in running their current, and in arranging their station. And I am heartily in accord with the idea, and I trust every station man will investigate the matter and look the the thing up and take hold of this subject in the proper spirit and carry out finally, not only the insurance part of it, but also this matter of organizing societies or exchanges. For the purpose of combining the interests of the electric lighting people and the insurance people in regard to wiring; and to enforce, in a proper manner, the rights of the association in regard to putting lines of wire into different places, as has been mentioned here. (Applause.)

Mr. Mason: Before Mr. Francisco retires, will you permit me, through you, Mr. President, to ask him a question? Do we understand you, Mr. Francisco, to object to the idea suggested, that there should be a national insurance exchange, as there is a New England insurance exchange, and as there are other exchanges?

Mr. Francisco: The idea of that is simply this: A national exchange would be too extended to be practicable. The idea is as suggested by the committee. For instance, we have now the New England Exchange. Then we will take in the middle States, then the Western States, the Southern States so as to make a department each by themselves, the same as the insurance companies do at the present time. In the insurance business we have what we call the Northwestern Association, the Southwestern Association, the Southern Association, the Middle Association and the New England Association. Now under this arrangement of the matter, we can carry it forward on precisely the same plan. Divide them up, but have them all under one head in the National Association. Bring them all into this association, but preserve your different departments, because if you do not it will be too large to manage economically. It cannot be controlled practically, as the territory is too large, unless we do this. You have got to have it so you can divide it and so that men engaged can go from one point to another without spending a week or ten days in flying across the country from the Atlantic to the Pacific. It is an important idea to preserve the different associations, but all to come into this national organization and this be the general head.

Mr. De Camp: The same as the National Board of Underwriters.

Mr. Francisco: Just the same; this National Association takes the place of the National Board of Underwriters.

Mr. J. E. Lockwood, of Detroit: I would like to suggest, in support of the idea that has already been advanced, of the harmonizing of the electric light and the insurance interests, a step that has also been taken in the direction of forming state electric light associations. This, it seems to me, is the proper time for the Electric Light Association to make use of the State association for the purpose of getting direct communication with each local organization in the country. The importance of this question depends, I think, in each State, upon the question of the organization of the electric lighting interest in each State and city. As there are electric light interests in each city, so also are there companies in each city, and the National Association is represented in the local organization. I think if this committee is formed its function could be more properly performed by creating and formulating the ideas derived from men of experience all over the United States, and which information could be gathered and furnished by the State Association. Then let each State Association apply in its own State this information, and instruct all of the electric lighting companies and the insurance men throughout the State, with the proper rules for wiring; and then through its own members, residents of every city of the State where there are electric light plants, see that these rules are carried out. In the city of Detroit, Mich., we have had the same thing to look out for. We have just formed a State association for Michigan. We have there a case where there are probably at present not less than half a dozen different companies doing wiring of buildings, in one of which that I know of the wires are being concealed within the mortar; and for a single light they are putting in No. 20 wire, which I know is smaller than is thought proper. In a building within one square there they are fitting up for two lights, No. 10 and No. 8 wire. Now, I believe, although that No. 8 and No. 10 wire for two lights is all right, but on the safe side, that man that will make that mistake may on the other hand make the mistake which will create a very great danger. We have fortunately not had a great many fires; but we have had our attention ealled to these facts and to the number of accidents in other cities, which have been published in the papers. Our State association intends making its best efforts to thoroughly investigate into this matter of wiring, and to formulate rules and endeavor to practically carry out these rules. We shall look over the work of the State and see that no work is done in the future that will not be strictly good electrical work. I only suggest that, and trust that when this committee is formed, that it will carry out this work in such a manner as to make the State associations the mediums of communications between the National Electric Light Association and the people whom we are going to reach.

Mr. T. C. Smith: I merely wish to say a few words in reference to what Mr. Francisco has stated. I do not want him to suppose for one instant that we allow such a state of things to go along when we know them. The point I wanted to make was that the moral character of the wireman was only good when you knew it. We have had a good many bank presidents and cashiers who were very worthy, responsible and trusty men—until they went to Canada. And it is the same way with the wireman. He is all right until you catch him. And in order to catch a man's moral character you have got to have some way to defend yourself from that man after you have found him out. Now, as I say, our record in Philadelphia on the question of fires shows we have a good system of inspection there; that is, that the work has been well done. What I mean to say is, that where a wireman is at work on the sixth or seventh floor of a building, and he has got one more joint to solder, it is an awful temptation to that man to twist a little copper wire and let that slide in a place where it will never be opened. It is a good deal more of a stress on him than comes upon a bank president to get out with a hundred thousand dollars, when he is twenty-five thousand dollars on the wrong side of his ledger. It is just that kind of thing that we have to deal with. You take a building with three thousand lights in it, and there are a good many of such, where every foot of wire is concealed. There you would have to put half a dozen inspectors on that one building, the whole time the work was being done, to know that every joint was soldered.

I am strongly in favor of a committee of this kind; but the point I want to make is, that we must look more to getting honest work, than to laying down rules that can be evaded. You must make it a question of principle. I would like to see some rule or system devised which would be practicable, and leave the question of rules as much in the background as possible.

With regard to electric lighting stations there is no necessity for concealing work of any kind. The rules that govern ordinary fire risks I think apply more to central stations than to any other building. I think there is infinitely more danger in the electric lighting stations from the boilers, engines and heating apparatus, than from the electric lighting wires, except, of course, the habit of throwing water on machinery that gets heated up, and I guess none of us would think of that, although we have heard of such things being done. (Applause.)

Mr. Cutter, of Chicago: About four years ago, I think, the New England Insurance Exchange was started. I like the idea of it. But have we got to wait four or five years for an exchange in the West, and then another lapse of time for one still further west, and then finally join them in the national exchange? Can we not start the ball rolling to-day, and from the National Electric Light Association have a national exchange that will establish the necessary organization? We do not want to wait longer in the West for the good results that you are getting in the East. We do not want to wait, and go from one town to another, for the good information that is to be had. We want, if possible, to start some sort of bureau or exchange, or association, whatever you may call it, that will be a national affair, one which will be the centre of information for the best class of work and the best policy to be pursued in putting in our plants. And we want, if possible, to start from this association and at this meeting. The sooner it is done the better, and immediate action is really essential. We want to start some movement that will establish an international affair.

Now, the New England Exchange has a sound policy and it certainly seems to me that the ideas expressed by Mr. Francisco are excellent. We want this to be on a

national and broad basis. I feel that if the wiremen of experience and the men who are working on important parts of construction are required to have a certificate from certain associations, and that when any wireman carrying such a certificate is placed on work and is caught leaving an unsoldered joint, or covering a joint with tin-foil, that he must lose his certificate—that is something more than a moral power. It is bread and butter for the next week or six months, and he will not want to lose that certificate. We want this committee to be appointed on a basis, if possible, for prompt action, to organize the National Electric Light Exchange, if you want to call it so.

Mr. DE CAMP: This is a subject which, as central station man, I am interested in; but it is one in which, in its various stages, I have never taken any part. I have watched very closely the actions of this committee. It is a question that is always before us, and always a source of interest, but it has occurred to me that the committee is doing a great deal of unnecessary work; that is, it is work that will come before them in the future. As Mr. Cutter just remarked very pertinently, we do not want to wait four or five years to educate up a corps of competent construction men. There is one point in this that ought to be considered: The old axiom that no rule is without its exception, is particularly true in this case. What is necessary to be done in one class of work is not so necessary to be done in another. Therefore I think that the true way for getting at this, in the first place, is for this very admirable committee to devote their attention to the education of a corps of first-class inspectors and let them be taken from among the construction men. Now that works in this way: As long as you are engaged in any business which has the cupidity of the general public to deal with, you are going to be utterly unable to control it by any set of rules and regulations which you may lay down.

In the case of the arc light company in Philadelphia, at least, and I think it is so generally, the cupidity of the user of the light is not appealed to from the fact that the company itself does the wiring; but in the case of the incandescent company, they cannot afford to do the wiring, and happily the rule has not been established. There the consumer pays for his own construction. What is the first thing he does? The lighting company that he applies to for light informs him that it is necessary for him to do a certain amount of work and that he will have to pay for it. For my part I would prefer that this should be done by outside parties. I do not consider it strictly in the line of the business in which we are engaged. He immediately sets out to find whom to get to do that work; he will give it to the lowest bidder ninty-nine times in a hundred. Now, he may have a responsible man bidding on the job, but the man who makes the most plausible statement and makes the lowest bid will almost always get it. The party who is letting the work has no means of knowing whether it is a proper piece of work or not. He is not educated up to that, and you cannot educate him, but he will believe what he is informed of by the insurance fraternity. He has an interest in his insurance, and he is not going to jeopardize that; if it comes down to a fine point, and the question is whether he will dispense with insurance or dispense with our light, he will dispense with the light every time. But if it is generally known that the insurance company with whom he is doing business have a competent inspector, it is a short road for him then; that man has got to do the work under an educated and thoroughly competent inspector, and it does not make any difference in that case whether he employ a good workman or bad workman until the inspector passes upon it.

Another duty that I think is an important one is to educate the insurance companies themselves to know just how much there is in this business. I think it is Mr. Woodbury who is responsible for the assertion that where establishments were properly wired, the insurance companies expressed a preference for that kind of risk, and they consider it decreases their risk rather than increases it. Now, that is just exactly what we want. That is exactly what will suit every lighting company, and if the insurance companies sustain their present rates on a decreased risk it will put money in their pockets. There should be no difference between the lighting companies and the insurance companies on that point, but there is a gross inconsistency about this matter between the lighting companies and the insurance companies. We have in Philadelphia, I think, three station risks that are first-class as risks, barring out anything electrical, but still the insurance companies discriminate against those risks, and give us a higher rate. We ask, Why? "Well, it is an electric light plant." That is the only answer we can get. We have to submit to that because otherwise we cannot get insurance. We get our insurance down to one half, and then it gradually begins to crawl back again. There can be no better proof than that that the insurance companies want our risks, although every once in a while they go up in their rates, and I think that, just as soon as we have a corps of inspectors that the lighting companies and the public have confidence in, you will get rid of a great deal of difficulty. It is one of the best ways of rooting out incompetent workmen.

I suppose there are fifty, may be a hundred, so-called construction companies in the city of Philadelphia to-day, and when we have occasion to discharge a workman the chances are two to one that he will turn up in time as an electrical engineer; that is the class of men we have going around. Without a dollar of capital they will take a bid on a contract amounting to thousands of dollars without the ability to carry it out; they manage in some way to get their goods; they will say they have such a contract, and want four or five hundred dollars' worth of goods and cannot pay for them until they finish the job, and when they get paid for it they will turn the money over. That is the only way they can do business. Now, if these men are watched and cannot get their work passed, and they cannot pay their bills, their creditors will find that out as soon as anybody, and in consequence there will be no bills to pay, and they will gradually drop out of the field, and that plan will result in raising up a good corps of competent men. We have in Philadelphia one inspector who has done all the good work that has been done there up to this time. He works by no set rules. He goes by common sense, and that he is pretty nearly right I do not think requires any better proof than the fact of the little trouble we have had up to this time.

Mr. M. J. PERRY, of Providence: One very strong point has been brought out by Mr. Smith, and that is that the combined insurance interest, rich in its aggregate capital of hundreds of millions of dollars, this morning requires to have the hat passed around in this convention to the tune of two cents to each lamp; that is a fact I am very glad to learn, and I shall take that back to my people with a great deal of satisfaction. You appointed a committee a year ago of which I had the honor to be a member. Its report has been before you for discussion. We labored during the year and brought forth our report, and I am quite proud of it. If we go on formulating exchanges and working down through school districts and up through counties and states, and finally having this grand National Insurance Exchange, we shall have a grand institution; but what will become of the wiring and the general progress of the business while we are waiting for that concern? If, one year ago, when this committee was appointed by you gentlemen of the convention, you had simply recommended to the insurance companies that they send their inspectors to first-class, reputable electrical engineers, and they had spent one week in connection with those gentlemen inspecting the installations in almost any town, at the end of that time, or a fortnight, they would have had sufficient knowledge to enable them to decently inspect almost any ordinary installation, and the whole thing would have been settled. That is where it has got to come finally, and we might just as well begin at that point as to spend a year getting there. There does not exist any necessity whatever for this grand and intricate organization, not the slightest. Why should our business be made a special exemption from the ordinary routine by which such matters are accomplished? Why is it that we are compelled to pay 80 cents for an arc light, while a gas company is called on to pay only 10 cents for a gas burner? There is not the slightest occasion for it; the thing cannot be gotten at. There is no mystery about the carrying capacity of a wire. For one cent you can buy a set of tables which any electrical engineer will indorse as being perfectly safe to follow. It is a very simple matter, and it is a matter that rests entirely with the insurance company finally to say that they will, or will not, accept the installation. The question of poor workmanship will be settled by that, and that very definitely. When a man or a construction company has made a bid so low that it is necessary for him to put in inferior work to protect himself from absolute loss, and he does it, and the work has been rejected by the insurance inspector, and the man with whom he has contracted has thereby been given a just reason for refusing to pay the bill, and he is obliged to reconstruct it and make it meet the demands of safety, there will be no more trouble; he will not repeat the dose. He will not want his medicine but once, and all of them have got to take it about once; that is my experience with construction companies. I do not believe that there is the slightest necessity for going into this work at all. I think that this convention should carry out to a great extent what we have recommended in the reports, that insurance inspector who steps into a building and is competent to inspect everything in it except electric wires, should make himself competent to inspect that risk and accept or reject it for cause. (Applause).

Mr. ARMSTRONG, of Camden, N. J.: I am very much pleased to hear from this member of the committee, and I trust he will pardon me if I say I like his remarks much better than I like his report. I do not believe that this convention ought to employ an instructor of insurance inspectors. If we are to go into the business of employing schoolmasters for the populace, the first thing we will have to do is to employ a schoolmaster to go to Ohio. I picked up a paper here in town which publishes an item to the effect that a member of the Legislature of that State had introduced a bill requiring all the dangerous electric wires to be buried throughout the whole State, and yet confessed in introducing the bill that he had never seen an electrical light wire or an electric light until four weeks ago, when he came to Columbus to be sworn in as a member of the Legislature. (Laughter and applause.) I am sorry to have to admit it, for the sake of the argument, and I trust it may not be held against me, but I have been a member of the State Legislature (laughter), and I know something of the wisdom and intelligence of State Legislatures, and if it is proposed by the aggregation of the electric light companies of the United States to endeavor to instruct men in what they ought to know, and what they give out that they are competent to do, we might as well surrender to them at once our whole plant and go out of the business. The insurance companies are to insure us, and as Mr. Carpenter well said, I think they will very readily and speedily find means to ascertain whether or not the work that is done is good. I happened to be the president of a hotel company that has constructed a hotel within about thirty miles of Philadelphia. We gave the contract to the lowest bidder, and so we ought to do. We would have been unfaithful to our stockholders if, when a man came, a reputable business man, and offered to do certain work for the least price, we did not give it to him. The insurance companies sent their inspector to see the work, and the work was condemned. We had not paid for it. We immediately notified him that we would not accept his work, and gave the contract to some one else; the insurance companies did that; we did not pay for it; we do not intend to pay for it. We do not purpose paying for this inspection; they are the ones to do the inspection and tell us whether the work is done satisfactorily or not. We do not know anything about it, and we do not want to know anything about it. I am president of an electric light company. I do not propose to have my company either inspect or pay for the inspection of buildings; we will furnish them the light; we will furnish them the current; they are to ascertain for themselves, or for the people who underwrite them, whether or not the work has been done properly. Now, certainly I cannot agree with that part of the report which recommends the employment of instructors for a year, for a month, for a week or for a day, for the general or the special agents of insurance companies. Let the insurance companies look to that. Why we would have to be instructing the mayors of some of our large cities and our city councilmen and our board of electrical control, and everybody else under heaven; we would have to instruct the populace that they must not go and take hold of a charged wire carrying 2,000 volts or any other number, and not expect to go into the great here-to-come, as one celebrated minister once remarked.

Now, as to the recommendation of mutual insurance companies for electric lighting, I should be very sorry—there has been no reference made to that part of the report—to see this convention, representing what it does, advocate the establishment of any company to manufacture wires, or any company to manufacture dynamos, or any company to manufacture lamps or switches or anything of that sort, because, as an electric light officer, I want to get the best at the cheapest possible cost to my company, and I do not propose to start something myself or in connection with other electric light men to beat down those prices; I do not propose to go into that business. I have one branch of business, and while mutual insurance companies are a great benefit at some times and in some places, and I want to indorse them to that extent most heartily, yet I feel that this convention would be making almost a fatal mistake if it adopted this report as it stands, recommending the institution of this mutual insurance company. Let us see ourselves that our work, so far as our plant is concerned, is done with regard to our own safety. Let us see that it is properly done, and then we may rest assured, as one gentleman on the committee, Mr. Perry I think, said, that this great aggregation of millions of capital in the insurance companies will furnish to us insurance and underwriters much cheaper than we can do it ourselves; so do not let us adopt that part of the report. Is there anything else left for us in that report to adopt? I want to adopt every one of the remarks of the gentleman; I am heartily in favor of everything he said, but I cannot be in favor of his report. One gentleman said that they had in their New England Insurance Association so bright inspectors that they will never pass tinfoil joints for solder. I did not suppose the pirates in the electrical wiring business would ever attempt to impose upon the people who know how to construct bass-wood hams and wooden nutmegs. (Laughter and applause.) But down our way, near Philadelphia, where we have been honest for more than 200 years, so that we have grown used to it (laughter) except for a few importations—I suppose they must have been importations—we have not had any accident by reason of defective wiring, I believe, in the State of New Jersey, of any moment that I can recollect, and I think none in Philadelphia; and it seems to me that the plan adopted there whether the companies pay to induce the insurance companies to do it or not, is the most profitable one. I am not in favor of it, nor will our company pay anything to the insurance inspector. The insurance inspectors do well. We will have nothing at all to do with the wiring; we do not want to have any responsibility for it, and will not, and, for one, I am not willing to indorse the organization of any electrical mutual insurance company. I vote for the remarks of the gentleman, but not for the report. (Applause).

Mr. PERRY: It is quite obvious that I failed to make myself entirely understood. My remarks relating to insurance companies apply specifically to wiring done outside of our station, but I do unreservedly want to put myself on record as indorsing the plan for a mutual insurance company for central stations.

Mr. ARMSTRONG: I do not indorse that part of your remarks.

Mr. PERRY: I have not asked the gentleman to do so. I was bound to give him the benefit of his own opinion, and let him give that to the audience, but I want to be distinctly understood as separating those two. I have my own views, as has the gentleman, about the advisability of central stations underwriting themselves. I am clearly of the view, after examining carefully into the workings of our New England manufacturers' insurance companies, that they can get insurance at a less rate than can be given to them by the stock companies or than they can procure from the stock companies, and therefore I want it distinctly understood that I indorse that part of the report.

Mr. P. H. ALEXANDER: New Jersey, as you all know, is different from any other State in the country, and therefore the insurance men there may be entirely different from the insurance men of other States; but we in New England have had the experience that insurance men refuse to insure us. Now what are you going to do about it? Are you going to go without insurance because you think they are wronging you? No, you would not do that. They do not know anything about electric light. I do not blame them. They think it is a dangerous element. They say we are writing an unknown risk, and we ought not to be put to the expense of providing a competent authority to ascertain how to estimate this new risk. They talk very fairly about it, much more fairly than you believe. When they found the risk was a good one, they reduced the rate, and to-day every building in Trenton that is lighted by electricity has a reduction of ten cents on its insurance rates. I believe the money paid out by the lighting companies is flowing back into their pockets. Their business has increased rapidly on account of the good inspection, and the good we are trying to do now is to do away with that inspection, and it cannot be done away with anywhere because you will stumble over the same stone that we did. The companies will say, "We won't insure the building; we don't know anything about it." Now, we want their insurance inspectors informed on this subject, and that can be done within six months or a year, and therefore the committee thought it would be better for the electric light companies to expend a small amount of money all over the country within the next year to provide the knowledge necessary for proper electric light inspection, and then reap the benefit that we are reaping now in New England.

S. E. BARTON, of Boston: I am very glad that this association has at last dropped the question of underground or overhead or quibbling where we should hold our next convention, and come down to the business of considering the subject before this committee of which I have the honor of being a member—the question of harmonizing the insurance and electrical interests. I was very much interested in the remark of the gentleman from New Jersey, but he evidently does not know what is going on in the United States. (Laughter.) I have been an insurance inspector myself for fifteen years; I would not consider myself competent to be an inspector to-day; I would not consider myself an insurance inspector in all that that term implies, if I did not consider myself competent to inspect an electrical installation as well as a gas installation, and that is the very point that we are hammering at in the report of this committee. Now we have had the industry of electrical lighting going on in this country—ten years or more of incandescent and arc lighting—and to-day, out of the nearly 1,000 inspectors that were employed by insurance companies over this country I do not believe you will find two of them that pretend to know anything about the inspection of electrical apparatus. Why is it? Simply because they have let that alone as a subject too deep for them, and left it to work out its own salvation, and in working out its own salvation you have

made the mistake here. The installations all over the country abound with errors that are incident to first construction, things that could not be avoided, but things that can be avoided and remedied in the future. Good inspection, you say, is what you want; you don't want to pay for it. You cannot get anything in this beloved country without your paying for it or giving an equivalent in some way. Now we have examined this matter, and we have taken the position that the man to inspect the insurance business is the insurance inspector who inspects every other hazard. He is not competent to do it to-day. You yourselves who have been in the business all these years know that he cannot be competent to do it without more instruction. He cannot qualify himself in a day, he cannot qualify himself in a year without an instructor. He is busy day in and day out from one end of the year to the other in his regular line of business. Now we have taken the stand and hold to the proposition that it is wise for the electric lighting people, not this association, but the electric lighting people throughout the country to put their hands in their pockets and say to the insurance fraternity, We will provide the instructors, not to instruct the people of the country and the legislators—that would be a hopeless task (laughter), but to instruct the insurance inspectors in what is necessary to qualify them in their inspection. By the appointment of a sufficient number of instructors you could furnish object lessons to these insurance inspectors, show them what is necessary when they have to discriminate between good and bad work by showing the good and the bad to them, and have the understanding that we do this perhaps as a piece of missionary work – call it what you please. This committee was appointed, not to point out what ought to be done, or what are the rights of the electrical people and what are the duties of the insurance people, but its very name says what it is for: It is to harmonize the interests of the insurance and the electric lighting people, and that is the way we believe they can be harmonized, by conceding on the part of the electric lighting people in the first place so many dollars and cents to be paid out by you people, and that to end at a given time. Give them fair notice in the beginning that they are expected at the end of that time to have their men qualified and competent to do it, and take my word for it they will be so; and then you have got your inspectors. You have not got to create them; they are already created, and they have been given the necessary instructions to do just exactly what wants to be done, and what you are after. Now, in Philadelphia, as Mr. Smith says, we are doing a grand work; but they are doing simply what we have been doing in New England for years, and you people are reaping the benefits of it. You are getting lower rates of insurance on properties lighted exclusively by electric lights than by any other class, and the insurance side is losing nothing by it; we are making money. From my standpoint as an insurance man I wish every other kind of illumination were driven out, and that electric lighting were the only thing used; we would then have a great many less fires. Those, Mr. President, are my ideas with reference to the question of inspection and to the recommendation made by the committtee. I believe it is something that ought to be done, and the voice of this convention ought to be unanimously for it, and, I believe, I can safely speak for the insurance companies and say that they will heartily co-operate with anything in that direction.

Now, I want to say a few words in relation to the project of an electrical mutual insurance company; I have had it in my mind for some time. If you will call to your minds one year ago at Chicago, in speaking upon electrical lighting stations as fire hazards, I said then that I believed the establishment ultimately of an electrical mutual insurance company, or something of that sort, would be the only solution to the question of insurance on central stations, and I believe it is so to-day; and I also said at that time that I believed that those few companies who are doing business in insuring electric lighting stations to-day, even in their deplorable condition, are making money. Now, I know they are. Since this prospectus has gone out no less than eight of the large and prominent English and American stock companies have asked to have a hand in it; just what we want; something that shall prepare the stations to make them good risks, and conduct them so that they will give us a part of the insurance, and that is the plan that is contemplated by the mutual company.

It is not intended to antagonize the stock interest at all; but, on the contrary, to take in with it all those who want to come, and eight of them have manifested that desire, and the largest American company, not to mention any name, stated to me recently that it has been insuring electric light plants, central stations, for several years at nothing less than two per cent. They have made that the minimum rate, and they have taken almost anything at two per cent., and have made money out of it; they have kept it to themselves; they now come forward and say, We do not want to lose that class of business, but we want to come into this plan and take our share of it. One of the smallest companies in the country, a company which started a few years ago, told me that it took electric lighting stations simply because they wanted business and could not get anything else, and within two weeks they have told me that their premiums in two years were over $60,000, and their losses less than $300 on electric lighting central stations. (Applause.) They want a hand in it; they have found that it was a good business, not because their wisdom taught them in the beginning, but because their necessities taught them. I think that you, Mr. President, advanced the idea to me that you thought your idea of harmonizing these interests did not coincide with the formation of an electric mutual insurance company, feeling that that would perhaps antagonize the stock interests. That is not so, in the first place; and in the second place, even if it were so, I would take the mutual insurance company, because it is undignified in the electric-lighting association to throw to the stock companies their insurance business as a sop to keep them satisfied. It is not necessary, in the first place.

I want to say a few words in relation to the examination and licensing of men employed in electric lighting installations, the work being done by the New England Electric Exchange. I cannot agree with my friend Mr. Smith, that that method does not give a guaranty of the character of the man. On the other hand, that is one of the important features of it. It examines him technically first; it then considers his moral aspect, and not a license is issued until it has been laid before and countersigned by the man who knows him personally and knows his habits and everything pertaining to him better than anybody else, and that is their inspector of the New England Insurance Exchange. Every license has to go before him, and receive his countersign, and thereby the exchange has the guaranty that that man is all right in every respect, and I know it is so, because I know that more than one man has not received a license simply because he did not meet the requirements in that one particular phase, while he did meet them in other points. Now, Mr. Smith says we do not need rules for the installation of electric lighting apparatus. I can hardly agree with him there. I myself feel that the rules that we have in New England are on the wrong tack, that if those rules were turned around, and instead of saying what should be done in the line of safety, they said what should not be done, it would be more in accordance with my ideas. But we could not start that way. We did not know in the beginning what should not be done. We knew in a crude way what should be done, we have gone on, and from time to time as experience has brought out things, we have added to those rules until they are complicated, and cover a great deal, not of ground, but of paper. and I believe, as Mr. Cutter said in the beginning, that it would be to the advantage of the electric lighting industry all over the country, if some sort of committee could be formed to draft a set of rules of some sort. It could be made a standing committee, whose duty it should be to consider and revise the rules from time to time; then we would have some rules that would obtain not only in New England, but in California, and even in Chicago; that is exactly what we ought to have. When we first started the method of examination in New England, we had a different inspector for each locality, one at Boston, and one at Portland, Me., New Haven, Springfield, Mass., and at Providence. What was the result? A party installing a plant in Maine was subjected to one set of rules; when he went to New Haven or Providence or anywhere else, he had to conform to a different set of rules, and that is the condition of things all over the country to-day. We ought to have some general rules so that the party installing in New England would meet the same rules when he went to any other part of the country. I would like to see a committee appointed for that purpose, and I would like to have a good part of that committee made up of insurance men who are the only men who can enforce any rules you make. You must work together with them. I would have a certain number of practical electrical experts on the committee, and these men could be selected one or two by this association, and one or two by your sister Edison Association; and let the committee be large enough to cover the whole country, and small enough so as not to be cumbersome, and let it govern the question of rules, and let these rules be condensed and solidified and brought right down to what is useful for safety, and then have the rules so framed that the insurance inspector, who can tell you all about everything except electricity, can undestand them. Then have men spread all over the country and see that these rules are enforced; and before you know it you will not need any further inspection. You will have, then, a great governing committee, who will stand behind this national committee on rules and amend them from time to time as need be, and the committee will be useful in many ways. Going back to the subject of mutual insurance, I want to impress upon you the importance of the fact that the inspectors of your mutual insurance company will be excellently qualified to give valuable ideas to the insurance companies. The company will break down all the barriers of prejudice; it will show to the country that you are not afraid to insure your own plants; that they are not those terribly hazardous fire-generating establisments that they are commonly understood to be. I hope that the recommendations of the committee will prevail.

President WEEKS: Knowing the good work done by the New England Exchange, and fully appreciating the importance of the work of this committee for the electrical interests of the country, the chair has allowed rather a wide latitude to this discussion. We have with us Captain Brophy, of Boston, of whom we have all heard much, and, I am quite certain, from whom we would like to hear more on this occasion.

Captain WM. BROPHY: I am pleased as one who has no pecuniary interest in any electric lighting company to have the privilege of saying a few words to this convention. I began, as you know, with the New England Exchange four years ago to supervise and examine the work done by electrical people. I am happy to say that, from the start, I had the hearty co-operation of every man engaged in that business. We have done, I think, a work that has been of exceedingly great value to the electric light fraternity in New England. I think any one here who represents New England will bear me out in making that statement. The insurance people were entirely ignorant of this new element that was introduced into buildings that they insured, and naturally were wary of it; they felt that it was no part of their duty to maintain this inspection at their expense, as all of the risks at that time were insured and rated before the electric light was introduced; consequently they made arrangements with the electric light manufacturing company to bear a portion, and a large portion, of that expense; they did so reluctantly at first, they did so with a great deal of doubt. To-day more than one of them have testified to me that the expenditure thus made has been returned ten, yes a hundred, fold. (Applause.) We have been exempt from injury to life and person in a remarkable degree. The three or four accidents that occurred there, occurred purely and simply on account of the negligence and recklessness of the unfortunate victims. Our losses from fire have been so insignificant that they are hardly worth noting, so far as loss to insurance companies was concerned. I wish to state here, emphatically, that the report made by the worthy Fire Marshal of the city of Boston to the Board of Aldermen that, in his belief, the disastrous fire of Thanksgiving Day was due to electric wires, was made without due deliberation, and with a wonderful lack of necessary information. Any one who knows anything about the condition of affairs there, must know that that was not the cause of that fire. I certainly do, and if I had any respect for the electrical knowledge of the worthy fire marshal of the city of Boston previous to his report, I have since lost it. (Laughter.) Now, something as to the work of the New England Electric Exchange. I was one of the promoters of that institution; I did all I could to force it into existence. Some vigorous English I made use of at a meeting brought forth that child. Now, as to Mr. Smith's objection that a technical examination will not reach the moral character of the man examined, I will say that I know every man engaged in the electric light construction work in New England. They are all my friends, and when I find a man whose moral character or whose habits unfit him to be in a responsible position, I do no hesitate to tell him so in plain and vigorous English, if necessary, and withhold my signature to his certificate, no matter how great a knowledge he possesses or how expert a workman he may be; so that we have no trouble from that source, We have had, since the organization of that exchange, a set of men employed in construction work that, in point of intelligence and in knowledge of their business, cannot be excelled in any part of this country. The time is fast approaching when the duties of the inspector must cease in New England unless he wishes to become a pensioner upon the bounty of the electric light fraternity, and he has not reached that age as yet. This is owing to the hearty co-operation of the men engaged in the electric lighting business in New England. As I stated to our executive board only a day or two before I came here, the work is now done so much better than when we began, that in many cases the duty of the inspector is simply a matter of routine; we have arrived at that happy stage by a rigorous inspection, by rejecting every piece of poor work that we could find, by impressing on the minds of those engaged in construction work the futility of attempting to palm off anything that was not first class; and in all this work we have not been obstructed in the least by the men most interested, the electric light companies and construction companies. With regard to these men who spring up in every village, who have strung a telephone wire, or a bell wire, or a gaslighting wire, and attempt to enter this business, we have a little rule that puts a stop to that at once: we issue a circular giving the names of men authorized by the New England Insurance Exchange to do construction work. A man who wishes to get on that list must satisfy us beyond a doubt of his own competency and his resonsibility before his name gets on the list, and now a party whose name is not on that circular has rather a poor chance to get rich in the construction business. There is a prejudice in the minds of the people that never should exist. Many people believe that death is present in every foot of electric wire. Many people believe that when it is introduced into their buildings their property is liable at any time to be destroyed by fire. There is no just reason why this should be believed. The men engaged in the electric lighting business in New England are as honest and as unwilling to hazard the lives and property of any of their customers as they would be to imperil their own, and the feeling that has been engendered in the minds of the public has been created largely by the sensational press of this country, and is one that never should have existed, and is a gross injustice to the men engaged in the business of furnishing the best light, excepting sunlight, that ever glimmered on the face of this earth. It is unjust that they should be subjected to such an outrageous raid on their business by the sensational press of this country, by men who write articles, but do not know the technical differance between a wheelbarrow and a dynamo (Laughter.) The time will soon come when the inspector of the New England Exchange will have to find some other field in which to exercise his talents; the only regret he will feel will be to miss the friendly greeting he has received at the hands of the men engaged in this business. I feel, though, that in justice to the men engaged in that business, his duties will be no longer called for. (Applause.)

Mr. T. C. SMITH: I am afraid I have not made myself as clearly understood as I should wish. I am not opposed to rules. The only objection I make to the rules is that they are too complicated. What we want is a few general rules of what should not be, rather than a great many small rules of what should be done.

With regard to the other point mentioned by Mr. Brophy, I am heartily in favor of having the insurance man the inspector. I believe there are many fires that are attributed at once to the electric lighting, when, if the building had been properly inspected the accident would not have occurred. We have had three cases of that kind in the last two months. In one case Mr. McDavitt went into a mill, the proprietor of which was in the state of mind that the public generally is, and thought he was liable to burn out any moment. The first thing that he saw was a large bundle of greasy waste, and he said, "You are in more danger from that pile of waste in one day than you would be from electric lights in ten years." The man we want as inspector is a man familiar with fire risks of all kinds, and I think our companies at Philadelphia show an appreciation of that fact in making it a condition of subscribing to the expense of this inspection, that no matter how many other experts are employed, Mr. McDavitt shall be at the head of the bureau.

Mr. WILLIAMS, of Ohio: I would like to offer a few words. Although I do not profess to any practical knowledge on this subject of insurance, yet I happen to be interested in several insurance companies who in the past few years have had a large number of central stations on their books, and we endeavor to get them periodically inspected. We have found ourselves confronted with very many difficulties. We have found that while our directors in several companies were practically business men and manufacturers, earnestly inquiring into the advantages and disadvantages of electric light, yet the business itself has developed so rapidly that it has been almost impossible for us as a small combination of companies, to keep pace with that development. I believe you will readily recognize the condition. Your committee to harmonize electrical interests with insurance interests is well named. I do not know whether it will ever be accomplished; perhaps it may be. Certainly at present those interests are very directly opposed. As one gentleman has remarked, you ask for insurance on a station and the company simply says the rate is so much, without entering into any calculation at all. That is simply their position. If you don't like it, you can go without insurance. On the other hand, our friends from the New England States have advanced very many strong arguments in favor of the reduction of rates. The question of the rate on the central station has not, it appears to me, been very much touched upon. There is this consideration that I would like to present. We are not altogether dependent in this country on the stock companies. I am glad to see that our friends have presented proposals for a mutual company. I hope it will crystallize into a good, solid, substantial company. The plans and purposes are in the direction of harmonizing those interests. They have taken pattern from the New England manufacturers' mutual companies. Perhaps it would be well to look back to those companies; we may

learn something from them. About forty years ago they commenced experimenting, and they have gradually followed it along, maintaining their inspectors and confining their operations mainly to the New England States, and are now progressing out into the far West; and our Western manufacturers, recognizing the advantages obtained from their inspections, are writing their insurance with them very largely. But all this has been done at the expense of the insurance company. They started out on the basis of the rate charged by the insurance company for insuring their mills, and they charge the insurance at those rates. They laid down schedules, and they have gradually raised their standard, until to-day, after forty years' experience, they are able to return to the members insuring with them 75 or 80 per cent. of the cost. At the same time that basis rate has been reduced over 50 per cent., so that the cost of insurance as stated in this prospectus is correct.

Now the New England Insurance Exchange—and I want to tender these gentlemen my most respectful acknowledgments for what they have done, and they have certainly done a great deal—followed in the footsteps of those New England Mutuals in this matter. For twenty-five years these companies have been favored, and are now willing to step in and take the advantage of what the mutual companies have done. If we take the same ground the stock companies have taken, with the rates as they existed, it would take twenty-five or fifty years to accomplish it, because they don't want it. Those companies want simply to look back twenty-five years or read the experience of the Mutual companies, and it seems to me that to-day they are not progressive companies that could be expected to harmonize the interests of the electric light and the insurance companies. It seems to me—and you will pardon me for speaking as a Mutual man, having spent some forty years in it—it seems to me that they are altogether too old; they move slowly, and you want companies that will move with you in developing and progressing as you progress and develop.

On this matter of inspection, pardon me if I say again that we maintain a system of inspection. We insure only manufacturing classes, and of course our inspectors necessarily have to acquire some knowledge of the electric light system. We endeavor also to have those men specially instructed by our own inspector on that very subject of the electric light and its dangers. We cannot possibly inter into the installation of wires in other buildings. It is not a manufacturing hazard with us; and so with every other insurance company. I take it that the question narrows itself down to the insuring of central stations and power stations; and if that system of inspection is to be adopted, it seems to me the only reasonable way in which it can be done will be at the expense of the companies. The central station should be willing to pay a fair rate at the outset, and let the insurance company get its statistics from the inspectors and ascertain the exact rate at which the insurance can be carried. That is the plan that has been followed successfully in the East, and I think it can be followed in the West. Then you avoid this necessity of educating inspectors. It seems to me if this association were to undertake that, it would be a very hard question. Who is to educate your first inspector and your sub-inspector? You have a mass of work on your hands that would be interminable, and certainly would not tend to harmonize the insurance and the electrical interests.

The organization of a State Association seems to me to be in the direction of harmonizing these interests, but there are other things to be harmonized. If you organize a single company and send it out with the stamp and the indorsement of this Association, will that tend to harmonize the other companies throughout the country? Can the Association afford to do it? It is for you, gentlemen, to decide. I would suggest that it would be perhaps well to find what companies would adopt that system of inspection, and whether that system of inspection would be such as would meet your own requirements, or whether those inspections would reach the standard that would be agreed upon by that committee on insurance. It that committee were appointed, it would be competent for them to ascertain such companies as would follow out that plan and give the members the benefit of the advantages of an inspection.

There is another question that would come before that committee. This is a progressive, developing business, and very many devices are being introduced from time to time. It is not merely a question of wiring. While I can indorse all that has been said by the gentlemen in regard to the defects of wiring, many devices are being introduced, some of them possibly very good, some of them excellent and some otherwise, and yet they are put in and dependence is placed upon them, and the result is bad. That committee, it seems to me, should have before them also the question of deciding upon the value of these devices; for instance, the question of inside wiring. Very many methods are adopted. If the committee lay down a standard, which of course from time to time would be modified as the business developed, and as the means were shown that standard would be raised and companies would be encouraged, and there would be advantage reaped on all sides. There would be a producing of harmony.

As to rules that have been spoken of, we are in favor of rules. We want rules. Nothing can work without rules, but they should be as simple as possible and be reduced to a clearly understood basis. Those rules could be formulated in this association from that committee, that should be composed of insurance and electrical men, and then every State association could adopt them and there would be no difficulty in arriving at a beneficial result.

There are very many other points in connection with this subject upon which I might speak, but the hour is late. I can only say that we shall be glad to aid in the organization and success of the Electrical Mutual. We will furnish the result of our inspections, and will endeavor to ascertain the dangers, and we shall expect you to assist us in avoiding those dangers. (Applause.)

On motion of Mr. M. D. Law, of Philadelphia, the report was adopted.

Mr. GEO. E. PALMER then moved that thereafter in discussions each speaker be limited to five minutes. Carried.

The following paper by Mr. C. J. H. Woodbury, of Boston, was then read:

CONSTRUCTION OF CENTRAL STATIONS.

While acting in co-operation with a committee of the National Electric Light Association, several years ago, it was necessary to examine into the matter of the construction and surroundings of a large number of electric lighting stations. Although these stations were built for the same object, and contained machinery and motive power devoted to the same industry, yet there was a diversity in their characteristics which was wholly inconsistent with their similarity of purpose.

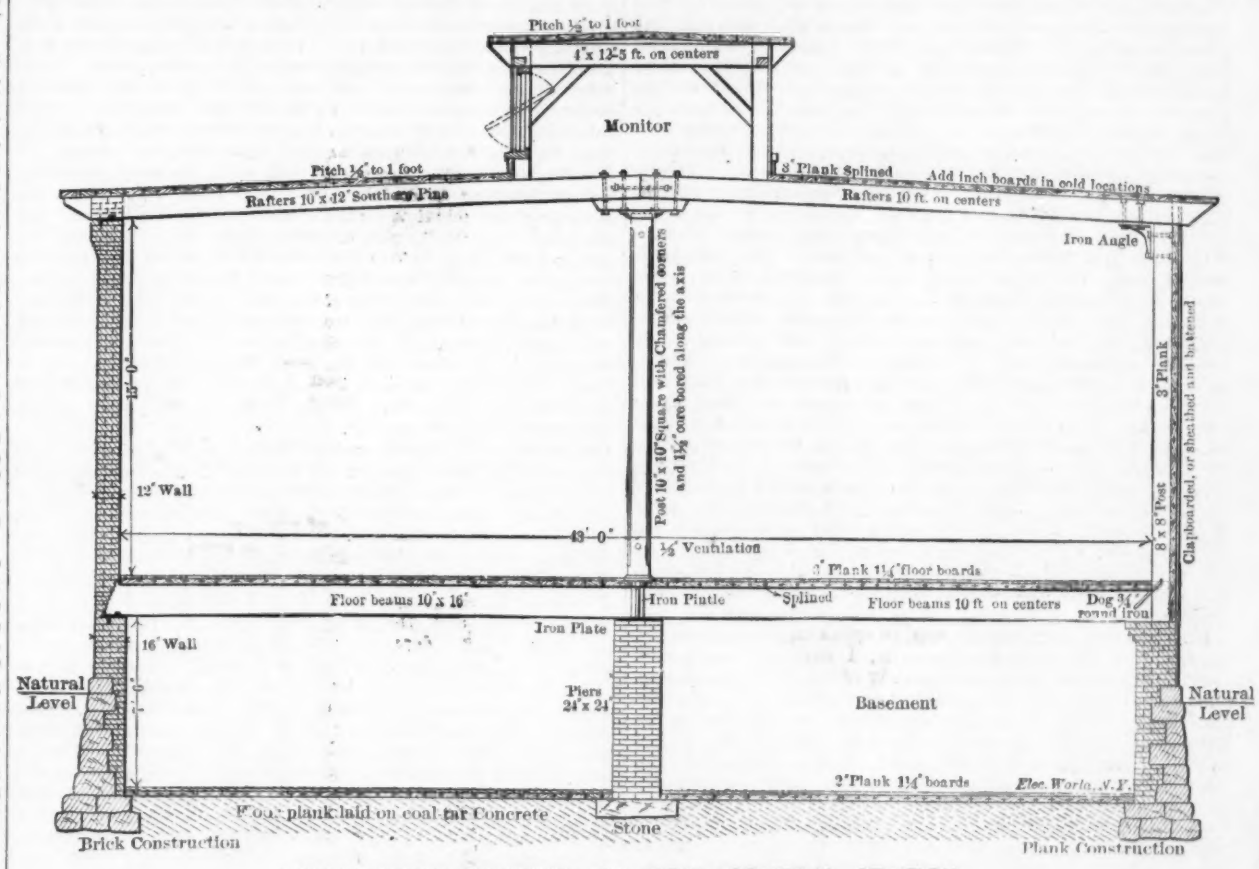
In accepting the invitation of your president to present a paper for consideration at this meeting, it appears that the subject of Central Station Construction might be a profitable one—not by reason of what may be contained in such a paper, but on account of the valuable experience which would surely be offered by the members participating in the general discussion of the subject, and in such a connection this paper is to be regarded as the opening of the discussion, hardly more than a parliamentary necessity, in order to bring the subject into a debatable form.

Many of the electric lighting stations in large cities have been built under easy financial conditions, where it was feasible to adopt suggestions for convenience, strength, and safety, offered by the engineers in charge of such work. Notable examples of such stations have been presented before this Association, or illustrated in the electrical journals. The opportunities for large stations have thus far been so few, and the governing conditions so diverse, that the problem requires in each instance an independent treatment, and is therefore unsuited for a general paper on the subject.

The larger part of the electric light stations are of moderate size, and were constructed under conditions of limited resources, which often compelled parsimony in the reduction of first cost, and did not permit the exercise of that judicious economy which yields the greatest return on investments.

A most important element in the arrangements of a central station should be the guarantee of continuous operation, in order to give patrons a necessary confidence in the stability of the service, which must be instantaneously equal to the maximum of customers. Many of the stations are in close proximity to other buildings of a miscellaneous character, and are built with hollow frame walls and thin roof, forming a structure which is hot in summer, cold in winter, and combustible all the year round, which disadvantages diminish dividends.

The location to be desired for a station should be, first, away from a proximity to other buildings, and therefore free from a fire hazard due to surrounding exposures. It is important that the engines



LONGITUDINAL SECTION OF IDEAL CENTRAL STATION.

should be provided with an independent condenser, but it is not necessary that the station should be near a water course to obtain a supply of water for the condensers, as is the universal custom in this country. A reservoir of suitable capacity, and not over 8 feet deep, will furnish a supply for condensers, which can be used over and over; the condensed steam and hot water entering one side of the reservoir, and the supply for the condenser being taken from an extreme side. If the water should not cool rapidly enough, it could be delivered from the condenser upon the top series of several nearly level platforms, thus flowing upon one and thence to the next in turn. In this way the water rapidly cools. Although the condensing capacity of such reservoirs might differ in this country on account of climatic differences from European practice, yet it is well to note that in winter when the short days cause the greatest demands upon a central station, the condensing capacity of such a reservoir would be greatly increased by reason of the more rapid loss of heat during cold weather.

In its general arrangements, a central station may be regarded as an engine room, and if well adapted to engines and the delivery of power, there cannot be much difficulty in providing accommodations for dynamos. The type of building suggested for consideration in its application to central station service in small cities, is the one-story slow burning construction, with flat roof, lighted by a longitudinal monitor, one end of which extends high enough to form a wire tower. It is not claimed that there is anything original in this design beyond a few minor modifications pertaining to its application to this specific purpose, for it is well known that beginning with one-story machine shops over twenty-five years ago, foundries, textile and paper mills, on the same general idea of construction have been widely introduced, wherever the cost of land was low enough to permit the erection of a one-story structure without raising the whole cost of the floor area, including the expense of land, to a price exceeding that of a high building.

The question of foundations does not pertain to this paper, but the importance of suitable foundations is too often slighted.

Franklin once said that next to a good foundation a good roof was the most important part of a house. The question of roof will next be considered, leaving the intervening pillars and walls for later reference.

The most convenient width for stations using an engine to every pair of dynamos is 43 to 45 feet, and the length of the station is in proportion to its capacity. The roof should be of three-inch plank, each 20 feet in length, grooved, and splined with hard wood splines, one half by one and a half inches, and laid on roof timbers breaking joints every three feet. In colder parts of this country, liable to temperatures below zero, it is good economy to lay a course of inch boards upon the plank, with roofing felt between. Pine is preferable to other lumber for roofing, as it does not warp so much as other soft lumber, and the roof covering will last better. The roof covering may be of any material for covering flat roofs, but its value will depend upon the quality of the material and the character of the work.

If these methods are followed, such a roof can be relied upon not to give trouble by condensation of moisture in cold weather, but care must be taken not to drive nails up into the plank, because being good conductors of heat, the heads would be cool and moisture collect on them. Along the middle of the roof, a monitor 10 feet wide, extending to 20 feet from the ends, will afford light and ventilation, while an extension of this monitor at one end to a suitable height will form a most convenient wire tower, if the monitor, in connection with an outrigger, should not be high enough for the purpose. The roof timbers should be of Southern pine, 10 by 12 inches, and laid 10 feet on centres. They should project 18 inches beyond the walls, and the ends be cut to form brackets supporting the overhanging roof and forming a solid cornice. At the ridge the two beams should be secured together by a junction bolt, and supported by column and bolster.

The walls of the station may be built of brick or of wood. If of the former a 12-inch wall will answer, with windows arranged as may be desired; but if of wood each roof timber should be supported on an 8 by 8-inch timber reaching to the sill, and secured to the roof timbers by an iron brace, and to the floor timber by iron dogs.

If the building is to be used for apparatus generating low-tension currents, the best floor would be made by laying coal tar concrete on a foundation of broken stone or cinder, and then laying three-inch plank upon the concrete, and covering this plank with one and a quarter inch hard wood plank laid across the bottom plank and blind nailed to it. Such a floor would sustain any weight liable to be placed upon it, but where there is need of a mass to hold rapidly moving machinery, it could be cut away wherever it might be necessary to lay heavy foundations.

On the other hand, if the generation of high-tension currents in the station imposed electrical conditions requiring a higher insulation of the floor, such as could be obtained only by an air space underneath, then it would be necessary to enter into a larger expense, and to lay a mill floor by placing the two thicknesses of planks on beams in a manner similar to the method described for the roof.

If the dynamos were placed on independent foundations, this floor would be strong enough, but if it should be required to sustain very heavy loads, there should be a line of piers supporting the beams under these loads. The lower portion could be made into a supply room; or otherwise, the front of the building could be divided by a light sheathing partition into a supply room and an office.

In its appointments, the building should be heated by two coils of three lines of one and a quarter inch pipe, each hung about three feet below the roof timbers, the arrangement of piping using exhaust steam for such a building being about one foot of one and a quarter inch pipe to every 70 cubic feet of space. Two coils are suggested, because the side occupied by the steam engines would rarely need any heat from the pipes.

The roof timbers afford easy means of securing a trolley track for making any changes and removing the apparatus or parts of the engine.

The protection against fire consists principally in keeping the establishment in a clean and orderly condition, the use of good lubricating oil, and careful attention to the bearings; and beyond that, numerous fire pails kept filled with water, and hose connected to hydrants ready for instant use, form the means for protection against fire.

If the boiler house is placed at one corner of the station, the latter can be extended by increasing its length; but if the boiler house is placed at the end of the station, the division wall should be made of brick and extend through the roof, entirely cutting off all wood connection between the station and the boiler room.

The wires could be run from the dynamos diagonally upward to the roof timbers, thus clearing the trolley track, and thence under the monitor from beam to beam to the switchboard on the floor under the front end of the monitor which forms the wire tower. This switchboard would be at the end of the unavailable floor space used for belts, and being in the middle of the room, is away from the walls, where any combustible material is likely to be placed. It is important that the switchboard should be made of soapstone or other incombustible material.

It is submitted that a station built in accordance with these general suggestions would embody the merits of convenience in operation, slight need of repairs, and, whether built with brick or plank

walls, would possess a resistance to fire which would reduce the fire hazard to a nominal amount; and although not so cheap in its first cost as might be made by using a lighter construction, yet as a whole it would conform to the strictest conditions of economy in a building to be used for a central electric lighting or power station.

Mr. M. J. Perry: A few minutes since the President told me personally that he had written me a month ago to be prepared to open this discussion. (Laughter.) I am glad he told me of it. (Laughter.) The gentleman who has carried the resolution limiting remarks to five minutes will also take notice. (Laughter.) It seems to me that this paper might be more properly entitled "Permanent Construction of Central Stations." It is about time that we began to look about and consider what sized central stations we shall have and where we shall locate them with a view to permanently develop the business of producing electric currents to be distributed for whatever purposes used throughout the communities where we are severally interested in this business; and it is possibly on that point alone that I shall offer a single suggestion.

I think I speak advisedly when I say that almost every central station man throughout the country has, upon finding his station too small, enlarged it to meet the requirements of all time, got it not quite completed, and found it was still too small. (Laughter.) I think we have rebuilt three times, but the last time we determined to settle that matter for a considerable period, so we bought a plot of ground 200x300 feet, covered it about half, giving us a dynamo room 60x200, so that we would easily handle the 4,000 lights in our city. We find now we have got to just duplicate that.

I think there are some general lines on which it is safe for us to proceed. It is a very important point, if possible, to so locate your central station that if you are inland, near a railroad, you can run a track in and switch your coal in right by the car; or if coal transportation can be reached by water, you can locate as near the water as possible, and get the advantages of water transportation. A suggestion has been made here how that can be accomplished if you are located inland—to locate near the water-side, so that you can erect your apparatus right alongside of the station. But the one great important point is to determine how large to build the station, that it may permanently serve its purpose for not less than twenty-five years in the development of this business. One of the ideas that suggested itself to me was, in solving this problem, to take the total gas output of the city and on the basis of 16-candle lamps reduce it to steam power and provide for from two to three times the total gas output. Speaking to you as intelligent men, I would say, buy your land now for the buildings you will erect in the future, and you will find it much cheaper. You will save more than 6 per cent., I will be bound, if I am any judge of human nature. No matter how public-spirited your neighbor may be, he will want a good round price for his patch of land. It seems to me that when you have selected your plot of land, you can build on some general lines and lay out your station to cover the whole plot and then leave a portion of it so that it can be added onto and in the end be a completed station. So far as we know to-day, we have got to rely on steam power. It seems to me the only thing we can absolutely stand by. There are a good many things in the air. You can say what you please about raising chickens from feathers, but when you really want chickens, the best thing you can do is to depend on the eggs. (Laughter.) You can safely buy up all the eggs, and the chickens will come in time. (Laughter and applause.)

Now a word in regard to boilers. Locate your boiler to develop this whole plot of land. Make arrangements with your engineer for that purpose. Then put in your first ones and follow that out on these general lines. Now, the question as to engines is a very important one, and, as we know, is a very much discussed one. My idea about that is, that when you have determined by that rule of taking your gas output, provided of course that your community is using gas extensively, you should take that gas output and multiply it twice or three times, as you have the courage to do, and then make your preparations to supply that amount of electric current and divide that into about ten units. Those ten engines are equally adapted to delivering the power on jack-shafts and belting up overhead, which I believe is the best way. By and by, when you get along with your unit as a 1,000 h. p. engine, you can drop your jack-shaft and belt right up to the engine.

As to what engine to recommend, I do not believe that I shall attempt to offer any suggestion on that point. After a careful investigation of the whole matter, and consultation with some of the more prominent mechanical engineers of the country, expert engineers, we decided to adopt, and have erected, a triple expansion engine built by E. P. Allis & Co., of Milwaukee, designed by Mr. Reynolds, the superintendent of the works. We have had it in operation now for about four months and we have never had the slightest trouble with it. It has done admirable service, and although it has not been tested it gives great promise. Whether it will reach the very high duty which has been guaranteed is a thing which Mr. Leavitt, of Cambridge, will determine. I have invited him to make a test, and he has accepted the invitation. I should not be surprised if we got at it within a month. It is a large plant, and we are tightening up the lines now, and shall be able to make the test very soon.

The type of boiler is a very difficult thing to determine. They are very much alike, and it makes very little difference so far as the evaporation of water is concerned. A 4-inch tube, whether it comes from one factory or another, will do the work.

One point I wanted to emphasize was this: when you set about constructing your station, it should be of a permanent character and there should be made very large and liberal arrangements for the growth of your business. If that is neglected, there will be the universal inconvenience which has already been suffered from starting up in a hen roost (laughter), or under a shed outside. I believe the loss of money in this direction is greater than in any other in central station experience. The fact is, the day has gone by for that sort of thing, entirely. The man who has a common wood-saw would carefully grease it and wipe it, and hang it up on a nail in a dry place, but he didn't hesitate to pay four, five, or six thousand dollars for an incandescent light plant and then stick the whole thing out in a shed almost without a cover from the weather. The thing has been so utterly absurd that it is hardly necessary to discuss it.

The strong point I wish to point out is the providing of ample space or ground. Buy it and own it. It is what you want for future growth and development. That is certainly a pertinent lesson that has been taught us by the universal experience of all men engaged in central station construction. (Applause.)

Mr. M. J. Francisco: I would like to ask the speaker if he recommends independent condensers? Has Mr. Perry had any experience in running an independent condenser?

Mr. Perry: We had designed for our station an independent condenser operated by an independent engine, and it had some unusual features. It is the first cut-off cylinder that was ever put on a condenser that I know of. We have been operating with that since about the middle of December, and it has been very satisfactory. We have a guaranty as to the steam or water consumed in developing a certain amount of power, so that it is to be brought down to the same level of economy as the main engine. The condenser which we are operating is a condenser designed to handle easily 2000 h. p. Our first engine is in and we have worked it up to 750 h. p., and have never had a minute's uneasiness. It has never been shut down for an instant. It has operated so satisfactorily that we have now contracted with the builders and they are at present constructing for us another engine of the same stroke, and the same diameter of fly-wheel and intended to drive on the same shafting up to 1500 h. p.

Mr. Fred. Sickles, of Kansas City, then addressed the convention on the subject of

THE STEAM ENGINE.

The theory of the steam engine has been so fully explained and is now coming to be so well understood, that it is scarcely profitable to take up time in reiterating it here, but there are some mechanical defects in the steam engine which are yet to be remedied and which it may be well to mention. I shall not mention any one device which is covered by any patent in anything I have to say here now.

Every device that has yet been used to admit the steam and to exhaust it from the cylinder, under the general name of valves, have had their especial defects. The old-fashioned slide valve, involves a great deal of friction, and while this is meant to be remedied by balancing the valve, contrivances which have been applied to this purpose, though more or less complete, have not yet balanced the valve, as the pressure upon it varies with the position of the valve; and all attempts to balance the old-fashioned slide valve with the rigid fit without elasticity or some yielding arrangement have proved failures, as in first applying the steam and warming the engine, the valves will warm faster at first than the surrounding steam chest, and will jam if care is not taken to give ample time for the equal warming of all parts; and any want of care on the part of the engineer in this respect will tend to work injury by the cutting of the valve when first starting the engine. In that form of piston valve which has piston rings, either one or two, the liability of leakage past the ring is encountered, especially as those rings cross the ports of the cylinder; and when attempts are made to work pistons with solid rings, then the difficulty of expansion is encountered. If a solid piston is used in the piston valve, it becomes necessary to make the piston slightly smaller than the bore of the seat to allow for the unequal expansion when first starting the engine.

The many-ported slide valve gives ample opening with but little motion, but it has extended edges to permit leaks, if not carefully fitted. The rotating slide valve, with a raised seat, is difficult to get at to keep tight, although it presents some advantages in connecting the valve motion to it. With balanced poppet valves the difference of expansion between the valves and the chest is liable to create a leak; but, if great care is exercised in fitting this kind of valve, and an ample guiding surface is allowed above and below on the stem, and the seats are made of not more than an angle of 22 degrees from the vertical line, with the valves and chest cast of metals of substantially the same rate of expansion, the valves can be made to remain reasonably tight. Yet, if great care is not taken in the adjustment and shape of the rock shafts for opening and shutting the valves, they are liable to make an unpleasant noise when running at any rate of speed. The single poppet valve can readily be made to work tight for a reasonable length of time, but it has the same objection as the double poppet in regard to making noise at high speed, and in addition to this it requires heavier valve gear, because, just at the instant of opening it offers great resistance. They do not waste, as a whole, as much steam as the double poppet valve. They can be arranged to have less clearance between the cylinder and valve. Indeed, single poppet valves have been placed directly upon the cylinder heads, thus giving very slight clearance. This plan has not come into use, owing probably to want of proper adaptation of the details of the mechanism. The whole subject of valves for steam engines presents a field for ingenuity.

It may be expected that the speaker will give some account of the trip cut-off valve with which his name has been identified for one-half of a century. To do so fairly I shall have to state the requirements of a perfect cut-off, which really cannot be secured, and the trip cut-off is only an effort to reduce the loss occasioned in working the cut-off. To describe this loss, I will state that steam may be assumed to have two different powers. One power is derived from the force it exerts in pressing against the piston as it escapes from the boiler into the cylinder. The other is the force it exerts after communication has been cut off between the boiler and the cylinder in expending and continuing to exert a diminishing pressure upon the piston. When the steam has exerted, say, nearly the whole boiler pressure at one-fourth of the stroke, and it is then desired to cut off the steam so as to obtain all the power that can be derived from the expansion of the steam already in the cylinder, the communication between the boiler and the cylinder would have to be instantaneously closed, so that the power derived from expansion in the cylinder might begin at nearly the boiler pressure and continue to exert a diminishing force to the end of the stroke. Any mechanism yet devised cannot instantaneously close the opening, for two reasons: First, it would be impossible, as far as we know, to put any machinery in motion sufficiently rapid to instantaneously close the opening; and second, if this rapidity of motion could be obtained, it would be impossible to absorb the momentum of the parts in arresting this very rapid motion. The best we can do in this regard is to devise some arrrangement which will move as fast as it is practicable to move mechanism, and then absorb the momentum of these parts in such a manner that no destructive violence will occur in arresting their motion. In the trip cut-off, the valve is liberated from the opening mechanism and is forced shut by a spring or elastic force, as shown in the original patent; and, in fact, in the original patent, the elasticity of the spring and the elasticity of the steam are both used to force the valve shut as rapidly as it is practicable to do so. The mechanism for absorbing the momentum of the parts may be explained by referring to what we see every day. We see that water and air in their action upon the earth disintegrates and destroys its surface in time, while neither the water nor air is injured by the violence. All the storms that have beaten upon the ocean have not injured one drop of water, while the air and water have washed and disintegrated the shore line of all the continents. Hence it is reasonsonable to infer that if the violence of the momentum occasioned by the use of the trip cut-off on rapidly closing could be absorbed by the motion of a fluid, whether water or air, a practical working machine would then be secured. It is only necessary that the valve in closing shall work some device like a plunger or piston which shall have this property, viz.: That it shall move freely in the fluid while the cut-off valve is closing, but at the moment of the closure it shall encounter the fluid by confining a portion of it. How is the power lost in the case of a locomotive that at one minute is developing 400 horse power with full boiler pressure, and having been suddenly flagged, is during the next minute exerting no power through the cylinder; (in the meantime the pop valve has jumped wide open and steam is escaping violently through it). The power of the steam is lost after the engine is shut off in forcing the particles of steam past the blow-off valve into the open air. In the same way, while the cut-off valve is slowly closing, the power is absorbed in forcing the particles of steam past the cut-off valve. It might be well for those who have yet to believe in the efficiency of the trip cut-off, and among these are some of the very best mechanics of the present day, to try the part which I presume they will have the most doubt about, that is, the checking apparatus or dash-pot. If they will make a controlling vessel so arranged that it will permit the fluid to escape freely until it is desired to arrest the momentum by confining a portion of it and forcing it through a narrow orifice of any sort, and will watch its action by letting it run in a shop or other place for any length of time, they will be entirely satisfied as to the reliability of the checking apparatus. In regard to the tripping apparatus, one objection is the use of a spring in the valve motion of a steam engine. It may be well to mention that it is not necessary to have a spring, as the weight will answer to re-engage the trip, or a positive motion can be secured; but springs or weights are generally used, and as springs are shown in the original patent, it may be well to consider the question of springs. The elasticity of metal is one of the laws of metals, as fixed as the law of gravity, and much of the prejudice against springs has been created by using them beyond their safe elastic limit; and when this is done, then the spring becomes an unreliable means of working mechanism. This fact may be illustrated by referring to an ordinary watch. The main spring of the watch frequently breaks, but the hair-spring, never. Yet the hair-spring is put in tension and compression from three to five hundred thousand times in 24 hours. And the reason is, the main-spring is taxed beyond its safe elastic limit, and the hair-spring is not so taxed. In cases where springs are used, if this consideration is kept in mind the spring can be made reliable within a reasonable limit. By applying this mode of reasoning to the trip cut-off, the remedy is obvious. The force necessary to re-engage the catch is so very slight, it is quite easy to make a spring that in performing this office, while not nearly taxed to its safe elastic limit, can therefore be relied upon with reasonable certainty to work the catch. If any good mechanic may yet be in doubt as to its certainty, it is an easy matter to add another spring and catch, so that one will act in case of failure of the other. This was the plan adopted in the original patent to overcome one objection that was anticipated against the use of the spring in working any part of the valve motion in the steam engine. An examination of the model in the Patent Office under date of May 20, 1842, will show these double springs. It is difficult to change the opinion of any mechanic except by illustrating. As there are now no patents upon it, it is public property. Probably the best way for inquiring engineers would be to test the catch or checking apparatus, and it will be found that they are entirely reliable as a practical question.

In cases where the trip cut-off is required to act at all points of the stroke it is best to use it in connection with the patent of Sept. 19, 1845, granted to the speaker, which has been variously termed "Independent Motion," "Universal Motion," etc., as it works the trip at any point of the stroke of the engine. This invention is in use on the steamers of the Fall River Line running on the route between New York and Boston, and many other vessels. It has lately been used on some boats on the Western rivers under various names. When the trip is worked by the valve motion, as shown in the patent of May 20, 1842, it is best to limit the motion of the tripping piece so that the cut-off will always act and not allow the steam to follow the full stroke by the excessive vibration of the governor.

The speed at which a trip cut-off can be made to work will depend somewhat upon the arrangement of the mechanism. The lighter the parts involved in the motion, the more rapidly they can be made to work with ease. A large steam engine, with large, heavy valves, has been made to work at the rate of 120 revolutions per minute, and indeed it would be hazardous to limit the speed at which a trip cut-off can be made to work, as, with the proper closing force and the proper absorbing vessel for the momentum, the speed of closing can be carried far beyond anything yet in use. But the cut-off is only a part of the engine. The motion of the steam valve in opening to work smoothly with the greatest power should be such that while it moves to give only a slight opening at the beginning, so as to gradually apply the steam as the engine passes the centre, this gradual opening should change into a rapid one followed by a rapid motion of the valve in cutting off the steam. The motion of the exhaust valves should be rapid in opening and rapid in closing, and one exhaust valve can open before the other closes, providing some means are secured to gradually apply the steam in the engine as it crosses the centre. But in practice there are only a few instances in which this gradual application of the steam has been used. I will mention one case in the speaker's practice. The steamer "Pilgrim," having an engine with a diameter of cylinder of 110 inches and a stroke of 14 feet, carrying pressure of steam as high as 45 pounds per square inch, was required to be altered from a Stevens valve gear to a trip cut-off, and it was necessary to retain the faulty steam connection between the boiler and cylinder and the faulty surface condenser, and do the best the circumstances would permit. To remedy the faulty condenser in part, the exhaust valves were arranged so that one was open 4½ inches before the other closed, to afford the greatest possible time in which to condense the steam from the cylinder, and this prevented any attempt at cushioning. It was necessary in working the steam valves of the new arrangement to so graduate their opening at the beginning of the stroke as to avoid any shock or jar that might come upon the engine by reason of the application of steam. As the valve gear was very heavy, involving tons of metal, the spring of these parts would tend to increase the sudden admission of steam, notwithstanding any gradual movement that might be attempted upon them; a plan was therefore resorted to of opening the steam valve an adjustable distance, say one-eighth of an inch, and then stopping all further motion for a short time so that the spring of the heavy parts of the machinery should not act by their elasticity to increase the opening. After the engine had crossed the centre, the further opening of the valve was commenced and continued until the cut-off acted. The entire

distance of opening of both steam and exhaust valves was 6¼ inches in this case. The indicator card still showed a defective condenser and defective steam connection, and it also showed what appeared to be a slight cushioning; but this appearance was deceptive, as the real cause was the steam passed around from one side of the piston to the other as one exhaust valve opened rapidly before the other closed, and the slight delay occasioned by the use of the faulty condenser increased this apparent cushioning upon the card. There could be no cushioning, because both exhaust valves were open, until the piston arrived at each end of its stroke. But the problem of applying to an engine of this size in the hull of a steamer without creating a jar had to be solved and this was done, as before stated, by a careful adjustment of the steam valves in opening so as not to apply the whole of the pressure at once. The first admission of steam in this case is marked by the sound of a squeal, indicating wire-drawing at the first motion of the steam valves. The indicator card shows a curved line on the admission end, proving the gradual application of steam. This was the best that could be done under the circumstances, and it was found effective in making the engine work smoothly while the main connections were quite loose, and saved a large amount of fuel by the rapid cut-off. No doubt she may still be seen running in the summer between New York and Boston on the Fall River line.

Any inquiring mechanic who desires to test the question of whether it is possible to prevent a jar by the gradual admission of steam, can do it in this way. He may put a very small valve upon one end of the cylinder of a steam engine and make an arrangement to give it an opening and closing motion. Then, if he will set this engine to pound on both centres and subsequently adjust the opening of this valve, he will find that it will take the pound off of one centre, in which it admits steam, by properly adjusting it, and in this way be convinced of the efficacy of the gradual application of steam to prevent a concussion upon a centre. Mechanics as a rule must depend upon themselves. The assertion of a fact by another is no proof to them, and hence I have stated a way in which they can satisfy themselves of the efficacy of the gradual application of steam. There are, however, many forms of valves in which this method of the gradual application of steam cannot be well embodied without too much complication, and for very large engines it might be well to apply separate small valves to ease the engine on the centre.

In most cases dependence has been placed upon what is termed cushioning to make the engine work smoothly, by shutting the exhaust before the completion of the stroke and allowing the steam yet remaining in the cylinder to be compressed. It may be said that all high speed engines of the present day use this plan to avoid pounding on the centre. Locomotives and high speed stationary engines depend upon the compression of steam to avoid a pound in the reciprocating parts. This compression necessarily absorbs a certain portion of the power of an engine, but it can be relied upon to secure smooth working. The price of coal, the interest upon the money, and the cost of reliable attendauce are to be considered in determining the best plan as a money consideration. This last remark is true in considering the construction of every part of the engine. A perfect valve has not yet been made; a perfect cylinder has not yet been made; a perfect packing for the cylinder has not yet been made; a perfect valve motion has not yet been made, etc. The packing of the piston should be such that it will work without friction; automatically adjust itself to the wear and to the irregularities in the bore of the cylinder, and also to the different temperatures of the piston and cylinder upon first starting the engine, and it must be tight. If the rings are made (as the speaker has sometime done) with an adjustable catch to hold them from being thrust out by a spring so hard against the cylinder that the steam could not force them back, then, as soon as any wear takes place, this catch will act to prevent the rings from following out the wear, and thus a leak will be created. Great care is required to manage an adjustable catch. Now, if the catch is not used and some force applied to keep the rings out against the cylinder as is usually the case, then if the steam leaks out by the rings and gets between the cylinder and rings, it may force the rings back and create a leak. If the spring is set so as to hold the rings out against the cylinder, and to resist the tendency of the pressure of the steam to force them back, then a great friction will be encountered between the rings and cylinder, and if the steam should pass behind the rings, it will force them out against the cylinder with additional pressure, and thus add to the friction. If an arrangement, such as has been made, is used to present a smaller area to the steam behind the rings than exists on the face of the rings, then the steam, in passing behind the rings and forcing them out, may be met by the steam which has passed down between the rings and cylinder, and, acting upon a greater area, may overcome the steam, forcing them out and force the rings back, this creating a leak. Indeed, it may be said that mechanics are almost in despair of producing a perfect piston packing. They have turned grooves in the piston, and in these grooves have inserted other packing rings; but, after all, the difficulty exists in that the steam is liable to force them in or out. If they are forced out, it creates undue friction; if forced in, a leak is permitted. If any attempt is made to have a fixed ring in the sense of preventing it from being made either larger or smaller, then the danger of more rapid expansion of the piston is met upon starting the engine. Also the difficulty of obtaining proper adjustment with ordinary attendance is met. So that a perfect piston, one that is automatic in its adjustment and comparatively frictionless and tight, as before stated, has yet to be made. All parts of the engine are imperfect. A realization of the imperfection of any machine may lead the way to make an improvement upon it; it is, therefore, instructive to search for defects in the steam engine.

A perfect lubricating arrangement for the journals, one that can be relied upon in all cases, has yet to be made. Of all the various forms of valves each has its particular disadvantage, and there yet remains to the inventor a wide scope in which to engage his efforts. But in determining upon any plan he is met at once by the consideration that a plan that might be good in one place would not be good in another, because of the difference in the interest on money and the price of fuel; and perhaps in another place the difference in the price of fuel and the price of efficient attendance; in another place the difficulty of securing proper repairs, as ,for instance, an engine in the mining regions. So it is quite impossible to give any specific directions for the construction of what might be called a universal steam engine. Perhaps at some future day some one will make a steam engine which will secure full economy in construction, economy in regard to fuel and efficient attendance; but certainly no such machine has yet been made.

As the cost of efficient attendance diminishes, probably an increase of efficiency of the steam engines can be secured. A machine that will work well in the hands of one person will sometimes prove a failure in the hands of another, and a constructor of an engine is constantly harassed by the questions: "Who is to take care and run this engine which I am now planning?" and, "How far can I rely upon efficient attendance?" And as often as he decides these questions he decides to some extent the character of the engine which he considers best for the purpose. Users of steam engines naturally desire to have their engines so constructed that they need not continue in their employ any particular engineer, but can change employés without danger to the sucess of their engines. Users consider this fact in determining the kind of engines to purchase.

A perfect governor for general adoption has not yet been made. All forms of governors in use depend for their action upon the change of speed of the engine, and when a small amount of steam is required to drive the engine, the governor must necessarily move faster to diminish the supply of steam, either when applied to a cut-off or to a throttle valve. When the governor receives the impulse to run faster, the working parts of the governor are restrained to some extent by the force transmitted through them to increase its speed, and hence, at that moment, it is not as free to act as it would be if no such resisting friction was applied to it, and yet at that very time the governor is required to move, and the result is, it does not move at first until sufficient additional speed has been imparted to it to overcome the friction created by applying the force necessary to create this additional speed; and when the governor moves, the friction having been diminished by reason of the driving force being less, it has a tendency to move freely and shut off the steam to too great an extent. Various appliances have been made to correct this by preventing the governor from moving rapidly in any case; but when this is done the governor may not move with sufficient rapidity to check the engine when the load is suddenly removed. Then again the parts which have to be moved have more or less friction in themselves, and the greater this friction, the greater the tendency to obstruct the free movement of the governor. We see in practice that unless a comparatively large amount of momentum is secured either by high speed or by a large fly-wheel, there is a great tendency of vibration in the motion above and below the required point. To overcome this the speaker at one time combined a governor arranged to receive its impulse through a driving arm and roller so as not to materially impair its sensitiveness, and then this governor acted upon the differential motion, patented by the speaker, which in fact separated all the force necessary to work the parts operating on the governor, and thus the governor was as sensative as the pendulum. But this arrangement was too delicate for ordinary attendants and was only resorted to in this case because of the peculiar surrounding circumstances. The patent on this arrangement has expired. It may come into use in some future time when the advantages of a very accurate running engine are more appreciated and when the cost of efficient superintendence is less than at present. I may mention that so perfect was this engine that on one occasion when the driving belt broke, the engine continued to run so nearly exactly on speed that the difference could not be noticed. It is possible to make an engine do this, but it requires great care in the construction of the parts of the governor and the differential motion and power cylinder attached to it. It also requires that all the incidental slack that may be in the parts between the first motion of the governor and its final application through the differential motion and power cylinder shall be provided against by either a weight or a spring which shall hold all this slack constantly in one direction, for this slight slack will still affect the action of the governor if it is allowed to act irregularly. Perhaps the best practical solution of the governor question at present is to provide a very large governor running at high speed, so that a very little change in the motion of the governor will effect a very great change in the amount of steam applied to the engine; then if this governor is driven by arms which bear against rollers inserted in the balls or weights, in the case of centrifugal governors, so that these arms drive the balls or weights faster or slower through the interposition of a delicately made steel roller that permits the balls or weights to move freely when any additional force is applied to them, a much greater accuracy of regulation can be obtained than is usually found in practice, provided care is taken that all parts necessary to be moved to control the motion wheel have very little friction.

It would be difficult to explain the whole matter without drawings: but I have endeavored to state the principles, which can, of course, be carried out by different mechanics. Governors for steam engines have been made in various ways, but nearly all of the kind which I am about to allude to have passed out of use, and I can best describe them in few words by stating the principle upon which they were built, and leaving the special designs out of the case. One form of governor was made by first generating a uniform motion, and this uniform motion was generated in different ways by different persons. One used a uniform motion acting upon a uniform resistance; another used a varying force upon a varying reistance and secured a nearly uniform motion by a governor; then this uniform motion thus generated was applied to control the motion of the engine by interposing between the uniform motion and the motion of the engine, a lever or cam so arranged that the steam engine varying this lever or cam in shifting its position would apply more or less steam,and thus the engine was controlled to run with the speed of this independent uniform motion. Another form of governor was made on the principle of moving a body in a fluid, and as the resistance increased by reason of the increased velocity of the steam engine, a spring or weight was moved and by its motion the admission of steam was adjusted to control the speed. But it is questionable whether it is not the best principle to have what amounts to a substantially powerful governor, as before stated, so that a very slight motion of this governor will be sufficient to regulate the admission of steam to control the speed of the engine; care being taken to secure almost frictionless action of the governor in its movements, and to separate any load involved in the action of the parts to control the steam, so that the governor may act as nearly as may be like a pendulum beating time. And, indeed, the point to be reached, as before stated, is to cause the governor to be as sensitive as the pendulum of a clock, and to be free from disturbing influences.

Governors have been applied to cut-offs from the early part of this century as early as 1812. As the trip cut-off required but little power to change the rate of expansion, it was well adapted to be operated by the governor, and its frequent use for that purpose has stimulated users of the different kinds of cut-offs to connect them to the governor with more frequency than was the general custom before the trip cut-off was invented. Almost any form of cut-off can be controlled by the governor, provided changing the cut-off does not bring too great a disturbing force upon the governor.

In regard to the steam engine of the future, if a metal is found that will enable steam of, say, 1,000 degrees to be used, and the escaping heat from the first boiler to be used in evaporating water to feed a second engine at 500 degrees, and then to a third engine that will make the draft by drawing the heated products of combustion through water whose evaporation will supply a working cylinder, that derives its power by receiving the steam below the atmospheric pressure and expands it to the lowest effective limit before discharging into the condenser—then we will have a combination using much less water per horse power than any engine yet made; but it does not follow that such an engine will be the most economical, as that will depend upon the interest charged for the use of money and the price of fuel; as it would cost more per horse power to build such an engine than one working under ordinary conditions. With money at six per cent. per annum and the cost of fuel to evaporate one ton of water at $1, a certain plan would be advisable. Again, with money at three per cent. per annum, and the cost of fuel to evaporate one ton of water at 50 cents, the same plan would be good; but as the cost of money and the cost of evaporating water change relatively, the best plan for economy in a steam engine would necessarily change to obtain the most economical result in the use of money. The cost of room for the plant and the cost of water for condensation, together with other contingencies, must be considered in any plan for a steam engine that is to be adapted to the surrounding circumstances under which it may be required to work.

The cultivated human eye and ear are wonderful natural indicators to determine the working of many parts of a steam engine. By watching any moving part of the engine and listening to the sound of the steam in the steam pipe, a good idea can be formed of the point of cut-off. By a closer attention to the peculiar sound of the rushing steam, the efficiency of the cut-off can be partly determined. By listening to the sound of the exhaust and watching the crank pin, a good idea can be formed of the lead; then by a closer attention to the peculiar sound of the exhaust, such as the time during which it can be heard, a fair idea can be formed of the exhaust line as it will appear upon the indicator card in this case. By a close attention to the motion of the reciprocating parts of the engine in crossing the centre, the effective lead on the steam valve can be ascertained, particularly if the engine is not set to cushion largely on the exhaust.

The human touch will reveal relative motion in contiguous parts of machinery that is beyond detection by the eye or ear, as, by placing a finger on two pieces that are apparently firmly in contact, a motion will sometimes be felt that is not visible. By cultivating the eye and ear and human touch to help in judging machinery, every engineer will be filled with a reverence for the marvellous powers of the human machine of which he is master.

Some blind persons can, by the sense of touch in their tongue, guide a thread into the eye a needle. Some watch makers can ascertain if a watch is running accurately within reasonable limits by holding the watch to their ear and at the same time watching the vibration of the pendulum of a standard clock. The carefully trained pilot in a fog or a dark night will depend upon his hearing to tell him when he is approaching an invisible object of any considerable size which projects above the water, as he will instantly notice a change of echo of the noise made by his vessel. Some engineers, trained to the sound of their engine, will notice a very slight difference in the working of any part by the change of sound, even when they are engaged in other work and apparently not listening to any noise.

To speak upon the steam engine generally is to endeavor to embrace a subject that has almost infinite aspects, and embodying innumerable plans of different men with fertile imaginations and ingenuity. The speaker has only endeavored to present a few views of the case in a short statement. The subject is too vast for complete treatment, and the life of an ingenious inventor can be occupied with efforts to improve only one part of a steam engine, and at the end find a vast space is left for further improvement.

The use of words to describe machinery, without the aid of drawings, must at present be unsatisfactory, as all of these words have meanings attached to them formed during a former civilization in which but little machinery was used, and the special sense in which they are necessarily employed in this statement must be understood before the intended meaning can be apprehended. A knowledge of the ancient and modern languages will afford no certain assistance in determining the meaning of words as used by mechanics in the absence of knowledge of the special meanings attached by them in describing details or mechanical operations. The dictionary depends mainly upon the leading authors for the meaning of these words, and probably they only know them as associated with ideas entirely outside of all engineering or mechanical connections. When in the progress of improvements a complete dictionary is established, giving the meaning attached to words as applied by mechanics or engineers in describing machinery, it will then be easier to describe, by the use of words alone, any mechanical operation so as to be more readily understood. At present it is like taking a cold chisel to do the duty of a screw-wrench, in many cases, when employing words to describe machinery. In the decisions in the patent cases before the courts, it has been wisely held that every patent is to be construed as meaning what is to be gathered from taking the drawings and words together, or, in other words, each patent furnishes its own dictionary. And it is reasonable to assume that the words the speaker has used in an effort to describe some parts of the steam engine will be taken to mean differently, to some extent, by different engineers or mechanics.

It is with some regret that the speaker is obliged to consider what he has stated as necessarily unsatisfactory, the pressure of professional engagements having prevented a careful preparation. A conference like this is well adapted to bring out facts, when, by the exchanging of views on various points, a much better understanding of the opinions of members can be secured for the benefit of themselves and all other interested parties.

On motion of Mr. Francisco, the meeting adjourned to meet the following day at 9:30 A. M., at Coates' Opera House.

THIRD DAY'S PROCEEDINGS.—MORNING SESSION.

The convention was called to order at 9:30 o'clock A. M., President Weeks in the chair.

Before proceeding to business, President Weeks announced that the badge of the organization entitled members to free passage on the lines of the Inter-State Rapid Transit Company and the Metropolitan Street Railway Company.

MR. GEO. E. PALMER, of Chicago, then read the paper prepared by Mr. Geo. H. Babcock, "On the Economical Generation of Steam for Light Stations."

The following paper by Mr. Geo. H. Babcock was then read:

ON THE ECONOMICAL GENERATION OF STEAM FOR ELECTRIC LIGHT STATIONS.

In the early days of the introduction of water-tube boilers we were frequently met with the remark; "Oh, they may do very well for woolen mills,but have you any in use in a cotton mill? How do I know they will answer for that purpose?" Or: "Yes, they may be very economical in a sugar refinery, but when you come to driving engines and steam hammers, that is another thing; they won't do for that." Of course the answer to such objections was that steam was steam, and that which made steam most economically for one purpose would do the same for any other purpose—the steam caring nothing whether it was used for refining sugar or driving engines for making flour, cotton woolen or cloth, or rolling iron. But, notwithstanding the plausibility of this argument it is not quite true,for the work to which steam is to be put,and the circumstances under which it is to be used, does, in a measure, control the conditions under which economy in its generation is to be secured. For instance, the most economical steam generator for railway locomotion would be a wasteful and inefficient apparatus for ocean navigation; steamship boilers and furnaces

could not be recommended for factory purposes, nor would the best of stationary boilers answer for a steam fire engine.

There was, therefore, good common sense in the choice of the subject upon which I was requested to address you. The equations which determine the highest economy in generating steam for electric lighting purposes are different from those which would solve the question of economy on a steamship, a locomotive, a fire engine, or even for an iron works, or a cotton mill, though many of the same quantities and much of the notation may be the same.

We need, therefore, first, in considering this subject, to ascertain the peculiar conditions which control the question of economy in electric light plants, and wherein they differ from those of other power stations. These conditions are:

1. The amount of steam required is not only quite variable, but is subject to unlooked for and sudden changes, which changes are in no way, under the control of the management. In places like rolling mills sugar refineries and dye works, where sudden changes in demand are frequently met, these variations are quite under control, and may be frequently delayed or avoided to favor the boiler house; but in electric lighting they can only be met by either supplying, or failing to supply the demand. The steam plant must, therefore, be one which will permit of quickly changing the supply to meet the varying requirements.

2. The maximum demand is for a short period in each day, at the best. A curve plotted to show the output of electricity in a station having a good patronage will show considerable variations day by day, but always a mountain peak at about the same hour. This is peculiar to electric lighting and has much to do with the question of economy.

3. An electric light station must be always on hand ready for work. It cannot take a vacation at the pleasure of its proprietor, the whim of its operators, or even the attending to of repairs. A breakdown not only stops its own work, but that of many others, and jeopardizes often great and grave interests. Providing a plant, therefore, with apparatus liable to break down or difficult to repair, no matter how cheap in first cost, or economical in the use of fuel, would be, in the homely language of the old adage, "saving at the tap and losing at the bung-hole."

In studying the question of economy in generating steam for electric light plants, it is quite necessary to take all these conditions into consideration in order to arrive at a proper solution, and to that end we must consider their controlling effect upon certain other elements which are common to all steam plants.

Requirements.

For the production of steam we require fuel and furnaces, boilers and brains—the last not the least by any means, when economy is the aim. Let us take these up in order and inquire what the effect of the environment has upon their selection.

1. Fuel.—This is a word which covers a multitude of substances, and locality has very much to do in determining the choice as to what fuel is best to use. For instance, in Bogota rosewood is found economical, in some parts of California peach-stones are used, while in other places saw-dust, pea-wood, bagasse from sugar-cane, spert, tan-bark, straw and numerous other substances compete with coal on the score of economy. Of course, we also have a great variety and great differences in prices. Anthracite, for instance, varies in price from $16 per ton in some South American localities, to 10 cents per ton, the price which the electric light station in Scranton pays for the use of the mountain of fine coal at its back door. Of bituminous coals there are numerous qualities, some of them worth fully double others for steaming purposes; but frequently the local coal of poor quality is cheaper than better coal brought from a distance. It is therefore necessary to determine this question for each individual plant, bearing in mind always that the cheapest in price is not alwas the most economical, and leaving the local circumstances to decide.

2. Furnace.—The kind of fuel having been decided upon the furnace needs to be adapted thereto. No one furnace is best for all fuels, and rarely for more than one. For anthracite a plain furnace with a grate fine enough to suit the size of the coal, and with the greatest possible air space, is excellent, and amply sufficient when intelligently fired. When, however, you attempt to burn bituminous coal in this same furnace, you get poor results and abundance of smoke. The same furnace, moreover, may not be suitable for two different bituminous coals, and it requires great experience to be able to determine just what furnace is best in each case. And just here one of the before-referred-to controlling conditions of the peculiar environment of an electric light station comes in to modify the selection.

It is to the furnace we must look largely for the ability to meet the sudden fluctuations in demand for steam. After the fires have been sluggish for a time on a small demand it becomes necessary to almost instantly freshen them up to vigorous action. Hand firing and natural draft do not easily meet this requirement, and here arises also the greatest difficulty in the employment of automatic stokers in electric lighting stations. They, as a rule, do not admit of sudden changes in the activity of the fires. There is much to be said in their favor for all places where the load is comparatively constant, and in electric lighting they will become a source of economy if they can be adapted to the sudden changes in demand, and can be worked with the same economy when firing for largely variant rates of combustion. To meet the controlling conditions some form of forced draft regulated by the steam pressure seems to be essential, so that the moment the pressure begins to fall the fire may be quickened automatically to meet the requirements. This has been done by attaching a pressure diaphragm to the throttle of the blower engine.

"Smoke consumers," so called, are generally wasteful of fuel, but frequently they are demanded to meet the requirements of local laws. It is well to understand that there is no such thing as "burning smoke," but furnaces can be made to produce a minimum quantity. In this, however, as remarked of furnaces in general, one coal is not any criterion for another. A furnace which will burn a given coal without smoke will frequently be found to smoke badly when supplied by another coal. This whole question of smoke production is generally more a question of brains in the fireman than of construction of furnace.

Automatic apparatus for handling coal and ashes is generally a step in the way of economy in electric light stations as in other steam plants. But this is also controlled somewhat by locality, as for instance when, as in the Edison station in Milan, they pay but 20 cents a day for firemen, the addition of a few extra ones for handling coal and ashes does not add greatly to the running expenses.

3. The boiler is perhaps the one thing which requires the most careful consideration in deciding upon an electric light plant. When we consider that in constant running a boiler, to speak figuratively, eats its head off every three or four months, it is plain that a reasonable additional cost for an economical boiler is a first rate business investment. In other words, a boiler which would save 10 per cent. of the coal would pay 30 to 40 per cent. on its cost annually and would be cheap at a round price as against another as a gift. But how may me know what boiler is most economical, when every boiler maker swears, with or without reason, that his is the one? Usually, in fact, the one with the least foundation makes the loudest claims, even going sometimes to the extent of bombastic challenges and offered bets, on the principle, probably, that that will enable him to rank among the better class. Preposterous claims are freely indulged in by the ignorant. I knew a case some years ago where a maker of a new boiler offered to guarantee under heavy forfeiture that he would evaporate nineteen and a quarter pounds of water to one pound of coal! And within two months I have seen a letter stating that a certain boiler, having no single element of economy, would do double the work in the same time, and with the same coal, that another boiler, which is known to give 75 to 80 per cent. of the theoretical efficiency of the fuel, could do!

Unfortunately, buyers are not all scientists, and, too frequently the biggest story, however preposterous and unsupported, if unblushingly made, is permitted to weigh more than real merit. But, as I asked above, how are we to judge and decide this question? Here are some general rules:

(*a*) Set down all claims to the evaporation of over 12 pounds water per pound of combustible (unless it be oil, gas or hydrogen) under any conditions, as made ignorantly or with an intention to deceive, and avoid such boilers as are claimed to do this as either humbugs or soda-water factories. (*b*) See if the boiler has the elements which are necessary to economy, such as a rapid and thorough circulation of water, thin heating surfaces, a well-distributed flow of the hot gases, of sufficient duration to secure thorough absorbtion of the heat, and ample disengaging surface to permit the steam to be drawn off free from entrained water.

In this matter of circulation of water a caution needs to be given, also, as against many unfounded ideas and claims. To secure an effective circulation of water the currents must not only be separated from each other, but they must combine to form a continuous circuit (without interfering eddies or material enlargements), until the steam is ready to be separated from the water. Thus a series of horizontal or slightly inclined tubes, open only at one end, have many interfering currents and but a very slight circulation. Return bends connecting two or more inclined tubes cause such a collision of currents going in opposite directions as to effectually destroy the circulation, and when tubes open into an up-take wide enough to admit a downward current within it, the most efficient factor of circulation is taken away.

(*c*) Observe the record of the boiler for a term of years. Single tests may be made to show superior results with a boiler which is anything but desirable for actual use. Tests made in regular work are best if disinterestedly made by competent engineers, but even here one needs to be on guard, as not infrequently tests purposely distorted are put forth as correct. A case in point. Near Manchester, Eng., a firm, having put in a water-tube boiler, employed a well-known engineer of a boiler insurance society to test it. He made out that it was evaporating only about 6 pounds of water per pound of coal—less than the ordinary Lancashire boilers. Suspecting that the test was colored by the well-known antipathy of all boiler insurance companies to any boiler claiming to be safe, on the ground that people may therefore not desire to have it insured, Prof. Kennedy, of London, the best known expert in the kingdom, was employed to make a test of the same boiler; and though it was, as he states, handicapped by the working conditions, he obtained under actual conditions of practice 10 pounds evaporation per pound of coal.

But it is not necessary to enlarge further on this point, it being admitted that in wisely choosing a boiler, the heaviest claims for economy are not necessarily to have the most weight. There is here, as elsewhere in the problem, ample room for a coefficient, employed by the late Hamilton E. Towle. At one time he read a paper before the Institution of Civil Engineers in England, and in all his calculations as placed upon the blackboard there appeared a peculiar and unexplained quantitative character. When he was through, one of the members rose to inquire the meaning of that mathemetical sign, which was quite new to them. "That, gentlemen," answered Mr. Towle, "represents the coefficent of common sense, which we find necessary to employ in all such calculations!"

But in considering the choice of a boiler for electric lighting purposes economy of evaporation is not the only necessary element. There are three others of as great importance, if not greater. One of these is the ability to be forced for a short time while the maximum load is on. This is very important, otherwise it is necessary to put in a plant large enough for the maximum and run it at great disadvantage, except for the two or three hours a day when the demand is at the greatest. But if the boiler, while adapted to the economical generation of the average amount of steam required, can be forced readily to meet the greatest demand, even if it should be at a reduced economy for the time being, the average economy will be better, and the interest account will also be less.

Another point of importance is safety from explosions. An electric light plant, as a rule, must be erected in the centre of thickly populated communities, and therefore it is more important, possibly, to secure safety from explosions in them than in most other steam plants. Now, while a common boiler may not be liable to explode under good care, yet one of the most difficult things to secure under all conditions is this good care. Even the best of men become careless or forgetful at times, and hence good boilers sometimes explode when least expected. It is far better economy, even at a greater cost, to put in a boiler safe from destructive explosions than to run the risk of a blow-up, with loss of time and capital, not to mention human life. Instance the Edison Company at Chester, Pa., where the explosion of a new and well-made return tubular boiler killed seven and wounded eight persons, besides demolishing the building. Even at a much higher first cost a safe boiler would have been good economy. But it is necessary in this matter also to employ a coefficient of common sense because so many claim safety for their contractions when they violate every element of security from explosion. As a rule a water-tube boiler properly constructed should be a safety boiler, but the mere presence of water tubes may be no surety whatever. For instance, a boiler with a large shell bored full of holes like perforated cardboard, and strained almost to bursting by reason of water tubes being expanded into these holes—an exceedingly unsafe construction—is advertised as a "Safety Boiler." Perhaps if the law in this country made the boiler maker criminally responsible for the accidents in such cases, as it does in France, there would be fewer such reckless statements. In applying the coefficient of common sense to this problem of safety, one needs to remember that a large shell exposed to the direct action of the fire and all flat surfaces, stayed or unstayed, are elements of danger, and that this danger is greatly augmented by insufficient circulation of the water, whereby unequal expansions are permitted to occur with consequent straining of the metal.

The third important question to consider in selecting a boiler for economy is its liability to repairs. A boiler which is under frequent repairs is dear at any price, and one in which repairs are not quickly and cheaply made is in the same category. This point is best determined by a long and extensive experience. Nothing else can decide it with any certainty. While tubular boilers may last for years in favorable circumstances, their *average* life is usually stated to be not over ten or twelve years, and their average repairs are usually estimated at ten per cent. per annum on their cost. Many go years without repairs, and I do not vouch for this estimate, only giving it as one accepted in ordinary calculations. As for water-tube boilers, the makers of the best known example publish the results of experience with an aggregate of 100,000 h. p., which had run from 2 to 20 years, and on which the average repairs to the boiler proper had been but about one-half of one per cent. per annum. They claim, moreover, and it cannot be successfully disputed, that in over 20 years' experience not a single boiler of that kind has been worn out in use, and that of all which have ever been sold in 23 years, not less than 98 per cent. are in use to-day. It is unfortunate, however, that the same cannot be said of water-tube boilers in general.

Last, but not least, we come to the element of *brains*. No matter how good or cheap the fuel, how perfect the furnace, or how unexceptional the boiler, unless brains are placed in charge, the preparation goes for naught. It is not difficult to find a difference of twenty-five, and even more, per cent. in economy between the extremes of firemen with the same plant, to say nothing of repairs and stoppages caused by a little carelessness. It pays to have men of brains as well as brawn and muscle, even for firing fuel and watching water.

We have thus hastily considered the necessary conditions of economy in generating steam for electric lighting plants. Let us review them as a whole.

1. The use of the fuel which gives the best results for the least money. This varies with the locality.

2. A furnace which will burn the said fuel to the best advantage, and at the same time permit of the rate of combustion to be quickly changed to meet the greatly varying demands without serious loss of economy between the highest and the lowest.

3. A boiler which will utilize the heat to best advantage; which will give dry steam; which will permit of being forced much above its average rating for short times without serious loss of economy; which is safe against destructive explosions and which is not liable to frequent difficult or costly repairs.

4. Foremen and firemen with brains enough to employ all these things to the best advantage, and keep the apparatus at a point of maximum efficiency.

In selecting these elements of an economical plant, it is urged that the coefficient of common sense should be fully employed, and that facts gained from long experience are a far safer reliance than mere assertions not backed by years of practical results.

APPENDIX.

The following items, having more or less reference to the subject matter of this paper, will, I think, be found of interest by the members of the Association.

Imperial Continental Gas Association, Vienna.—This plant which has been at work since August, 1887, is very complete and efficient. Its principal work is lighting the Opera House and Hofburg Theatre, which contains the equivalent of nearly 15,000 incandescent lamps of 16 c. p. each. At the station there are eight Babcock & Wilcox water-tube boilers, each having a heating surface of 131 square metres, which are fired entirely with coke and supplied with water from the Danube Canal, which, however, is filtered and chemically purified before being fed into the boilers. Four Worthington pumps are so arranged that the water may be pumped direct into the boilers or first through an exhaust steam heater, all connections being in duplicate. The engines are Willan's direct-acting high-speed, three of 170 indicated h. p. each, and five of about 130 h. p. each, and four smaller ones. These engines run from 400 to 700 revolutions each, according to size. The engines are coupled direct to dynamos of the vertical double magnet type by Messrs. Crompton & Co., the three larger ones giving 250 ampères at 400 volts and the five smaller ones 130 ampères at 450 volts. The small dynamos running at 700 revolutions per minute give 150 ampères each at 55 volts and are only used for exciting the magnets of the larger machine.

The engine room is fitted with an eight-ton overhead traveler to facilitate repairs, etc. In the central station is also a workshop supplied with lathes, winding head and other tools necessary for effecting all repairs, as also a laboratory photometer room and the necessary offices of the building. In the cellars of each of the buildings lighted are placed large batteries of accumulators having 100 tons of plates in each, which are charged during the day from the central station. At night and during the performance the current from both machines and accumulators is used, the latter serving both for storage and regulating purposes.

An elaborate test of this plant was made by Inspector Ehrendorfer and T. W. Melbush, A. M. I. C. E., a graphic representation of some of the results of which is hereafter given. The following is a summary of economical results obtained, the coke and the chimney gases having been carefully analyzed to determine the available heat in the coke and the amount carried off in the chimney.

The theoretical evaporation with one pound of coke, of water from 32 degrees to steam of 212 degrees, in pounds	11⅓	
of which there were used for generation of steam	79.21	per cent.
There was lost in the chimney gases	15.47	"
Waste of coke in ash-pits	.88	"
By conduction and radiation	4.44	"
Total	100	"

77.59 per cent. of the indicated horse power was delivered in electrical horse power. The consumption of feed water per electric horse power per hour was 38.05 pounds. The consumption of coke per electric horse power per hour 3.78 pounds.

The largest proposed electric lighting plant in the world is that of the London Electric Supply Corporation at Deptford. The buildings now erected are intended to contain when finished 80,000 h. p. of boilers with the corresponding engines and dynamos. At the present time there are erected twenty four Babcock & Wilcox boilers of 250 h. p. each, and two compound Corliss engines of 1,500 h. p. each. There are now being erected four engines of similar design of 10,000 h. p. each; that is to say, these engines are double, one-half of which are at first to be erected to work at 5,000 h. p., afterward a second engine to be coupled to the same shaft, making them full 10,000 h. p. each. Each engine is to drive directly a single dynamo sufficiently large to employ its entire power. The smaller engines, 1,500 h. p. each, are to give off 1,250 electric h. p., after deducting loss in mains, switches, flues, etc., and the 10,000 h. p. engines with their single dynamo are to give off 10,000 electric h. p. each. The exhaust from the engines will be connected into one main, with separate condensers worked by independent engines. The dynamos are constructed for the alternating current. The exciters are driven by triple expansion engines running at 280 revolutions. The feed water for boilers is taken from the hot well and pumped through economizers, of which there is one in connection with each battery of six boilers. Steam pipes are of copper throughout, feed pipes partly wrought iron and partly copper. The pressure of steam carried, 200 pounds to the square inch; all exhaust, not only from the main engines, but from the feed pumps and blower engines, is carried into the condensers. The plans for this station contemplate its enlargement at a future day, when it is expected to contain 120,000 h. p. of boilers and engines. It is to be worked on what is known as the Ferranti system, with 10,000 volts E. M. F.

The same company have another station at the Grosvernor Gallery, which has been running for some years. It contains four

Babcock & Wilcox boilers of 164 h. p. each, carrying 140 pounds pressure, which are worked continuously night and day to upwards of 1,000 h. p. The engine room contains one Corliss engine of Hargreaves' make, 4 feet diameter of cylinder, running at a piston speed of 780 feet, and coupled by ropes to a Ferranti dynamo with a capacity of 15,000 8 c. p. lamps. Three other horizontal high-pressure engines, with ordinary slide valve expansion cut-off gear, are connected to a countershaft from which another dynamo of smaller capacity is driven. Another engine and dynamo is kept in reserve for lighting the Grosvenor Gallery or to act as an exciter to either of the above dynamos. The exciters of the large dynamos are attached to an amature shaft and form really part of the machine itself.

The next most important electric lighting company in London is the *Metropolitan Electric Supply Corporation, Limited*, who have at present four stations, of two of which data are given:

Sardinia Street Station.—This contains four Westinghouse engines, of 250 h. p. each, driving by belts alternate current dynamos, and two smaller Westinghouse engines, of 50 h. p., driving exciters by means of belts. There are five Babcock & Wilcox boilers, of 250 h. p. each, carrying 150 pounds pressure per square inch.

Rathbone Place Station.—Five boilers of 160 h. p. each, carrying 200 pounds pressure per square inch, and six Willan's triple expansion engines, coupled direct to Elwell-Parker dynamos, giving 1,000 volts and 100 ampères, at a speed of 355 revolutions per minute; number of alternations, 12,000 at this speed. Two smaller similar engines are coupled direct to continuous-current Elwell-Parker dynamos, giving 150 volts and 180 ampères, used for exciters. All the connections, both steam and water, are made on the multiple-arc principle.

The Kensington and Knightsbridge Electric Light Company have two stations, one at High street, Kensington, and the other at Chapel place, Knightsbridge. In the former are two Babcock & Wilcox boilers, giving 500 h. p. indicated, and two high-pressure compound Willan's engines directly coupled to Crompton dynamos. This station is soon to be increased to about 2,000 indicated h. p.

In the Knightsbridge Station there are two Babcock & Wilcox boilers, giving 700 indicated horse power, the engines and dynamos being substantially the same, which is also to be increased to about 1,900 indicated horse power. In the two stations there are, therefore, after making allowance for spares, about 1,900 kilo-watts available, or the equal of 57,000 ten c. p. lamps lighted simultaneously. As in the Crompton systems accumulators are employed as a means of distribution and reserve, these stations will be equal to the supply of 75,000 lamps burning simultaneously, and, according to London practice, 150,000 lamps can be rented out.

The cost of producing a unit has steadily decreased in this station, until it is claimed that the cost for fuel, oil, water and all wages and material used for working the station and other general repairs, being divided out of the number of units sold to consumers during the month, amounted to only 1½d. per Metropolitan unit Messrs Crompton & Co. would be very much interested to know whether, in America or any other country where the work is being carried on an equal scale, any economical efficiency approaching that has been obtained.

PRESIDENT WEEKS: You have these papers of Mr. Woodbury, Mr. Babcock and Mr. Sickles before you.

Mr. SICKLES: I do not know that I shall discuss my own paper, but I will discuss the paper on boilers. I would say in regard to Mr. Babcock's paper on boilers which has just been read that I agree with it in the main; but I object to one statement, which I think it is right I should mention, and that is. the statement that stayed surfaces are unsafe. Now, this is a question of fact. We have tried boilers long enough to know whether stays are unsafe; and we have in the world thousands of locomotives running into stations every minute with a large amount of stayed surfaces in them, for 50 years, and not one of all these has ever failed. It is not true that stayed surfaces are unsafe. They may be made unsafe, but they are not necessarily unsafe, and, therefore, I shall have to object to that part of the statement. But the general scope of the statement I think I can agree with. The idea that you must put a very rapid current through a tube and subject it to the passage of the heated gases at right angles to this tube is correct. All experience shows that the best results have been obtained by placing the tube in that position where the current will pass rapidly through it, and the heated gases impinging against it at right angles, as a matter of evaporation. But, of course, common sense, when we come to reflect, will tell us some things. This tube must be made so as to carry high steam, and be reasonably small, so that we can get a large amount of surface in a small space. And it only comes then to the question of what is the best way to get that general result. I do not think it would be proper for me to mention any particular form of boiler that would be likely to come into use in an electric light plant, because I do not wish to talk of any particular plan. But I will mention one plan that will never come into use in an electrical plant, which illustrates, however, the value of very rapid circulation, with the gases impinging upon it at right angles, and that is the Herreshoff boiler. That is an apparatus of enormous ability for the surface, and gets a very wonderful result, of course, at disadvantages that would be utterly impracticable in an electric light plant.

I believe, so far as being able to force a boiler is concerned, his statements are correct. It is important to so arrange the boiler that it can be forced in an emergency, and not be obliged to carry a large number of boilers that would be available, perhaps, only an hour in twenty-four. It is better to sacrifice a little economy rather than have too large an amount of money lying idle, as would be the case in having too large an amount of boiler service. (Applause.)

Mr. T. C. SMITH, of Philadelphia: I think that the question of boiler service in a station is one of the most important we have to deal with; and I think that there are two or three points about central station work that should be taken into consideration, in discussing the form of boiler to be used.

With regard to the question of being able to force your boilers, that proposition has another side to it, beyond that of the mere question of having money lying idle. There are very few central stations doing incandescent work, in which the bulk of the load does not come within two or three hours in the day, and the load at that time will be enormously in excess of the average load. If you can force your boilers during these two or three hours, by keeping the fires clean, and being ready for the heavy load when it comes, you not only save the cost of a surplus boiler plant, but you save very largely in your fuel consumption. I know of a station where the fuel consumption is increased 50 per cent. by the necessity of having to fire up the second boiler for the two or three heavy hours' duty between four and eight o'clock. The banking of your fires during the day must be done or you have to make a fresh fire. In order to carry a banked fire it takes as much coal—a good deal more coal—than would be sufficient to run that heavy load, if you are able to force your boiler a little more, and burn that coal under the boiler that was being forced. For that reason I think that a large source of economy will be found in central stations by putting in a forced draft apparatus, more than in increasing the boiler capacity. I know there is strong prejudice against forcing boilers on the score of danger from it, but I do not think that any electric light station should be run by any man that cannot be trusted to force a boiler without endangering it. I do not mean to force a boiler, of course, beyond a reasonable degree. With regard to the remarks on flat stayed surface, I have only one thing to say. I was brought up on the big shell boiler, boilers running anywhere from 6 to 7 feet in diameter, and one or two big flues through them; and there are several points in favor of that boiler that ought not to be overlooked, such as the easy cleaning and examination. Now it seems to me that when we once leave that large shell and come down to the use of tubes, that we might as well throw out the whole thing and get rid of every objectionable feature in a boiler that we can. Now it is true that flat stayed surfaces have been used for many years. It is true that the bulk of the locomotives in the world are using flat stayed surfaces in their firebox; but I think that ever since the flat stayed surface was put on locomotive boilers, there has been a constant desire to get rid of it if possible. It can be made safe, but it is always liable to deterioration, and to get in an unsafe condition. I do not know anything that is easier to get in a bad condition than a flat stayed surface. Therefore, I think if we get rid of the flat stayed surface it ought to be done. If there should be two boilers, one of which has the flat stayed surface, and the other of substantially the same construction and principle, which is without it, I would always use the boiler without the flat stayed surface. (Applause.)

Mr. SICKLES: I will say in regard to the flat stayed surface that one element of safety in it is this, that the flat stayed surface, where you are carrying a regular pressure of steam, yields very gradually, and it will give you notice weeks ahead that it is going to give out. You will frequently see a flat stayed surface bearing indications for months before that it will give out. Hence, there is a certain measure of security in the flat stayed surface in that respect. It yields slightly; you can see the boilers running with a flat stayed surface, with a notice, you might say, painted upon them. They will still run for a while; but, of course, there will come a time when they will give out. But the practical fact is, there are hundreds and thousands of locomotives running into railway stations all over the world, that have been running for half a century, that have not given out in the flat stayed surface; and that fact is to be taken against any number of opinions on the subject. I hold that a mechanical fact, so strong as that, cannot be answered by the belief of any number of persons.

Mr. T. C. SMITH: I would like to ask Mr. Sickles, if he has any figures showing the cost of keeping up these flat stayed surfaces in locomotives. I have been employed for a short time in locomotive shops, and I know that engines never come in off the road but that the flat stayed surface had to be tinkered with.

Mr. SICKLES: I can say that every part of the locomotive boiler deteriorates very rapidly, and the gentleman will find if he will look over his memoranda, that he tinkered as much with the tube as he has done with the flat stayed surface; that every part of a locomotive boiler gets out of order; it is a sort of a cupola on wheels. (Applause.)

Mr. C. J. FIELD, of Brooklyn, N. Y.: I do not think that we ought to pass over Mr. Woodbury's paper, submitted yesterday, without looking at it a little more carefully. We all know what Mr. Woodbury has done in New England mill construction. New England mill construction, in the last few years, has done more to bring up the standard of buildings of that class and make them safer against fire than any other class of construction in the country. And when we see that these principles can be applied to small station construction, I think these points are such as the electric light company ought to know and give attention to. When we can go into small towns and stations with hollow walls overhead and all those things that go to make bad construction, and at very little expense make them as safe as fire-proof buildings almost, as far as fire is concerned, I think it is a matter that it will be profitable for us to consider and carry out.

Mr. M. D. LAW, of Philadelphia: In the management of electric light stations there is one point that has not been specified by Mr. Woodbury, which is very important as regards safety against fire. I have discovered the same trouble in Kansas City in the plants that are located here, especially in some of the private installations, and that is the packing of waste underneath the machine for the absorption of oil. It perhaps looks to you like a little matter, but in nearly every case, especially where high-tension currents are employed, you have to use a wooden floor as a measure of safety. By packing waste under the machine you place a tinder-box there. It may run for years without any trouble whatever, but in the case of an armature's burning out, and armatures will burn out and throw fire for a long distance, this ignites at once, and you have a nice little fire to take care of. I speak of this because I had the same trouble several years ago in packing waste under a machine, an armature burning out and dropping some melted copper on the waste. The consequence was that all four field magnets had to be rewound on the outside, and we came very near having a nice fire in our station. It was only by having water buckets in close proximity to the machine and rubber blankets that saved us. The rubber blankets, I think, did more toward putting out that fire than the water buckets. They were immediately grabbed up and thrown over the fire and smothered it. I saw Mr. Woodbury had not spoken of that matter, and it is an extremely important one. Mr. Woodbury has given us an explanation of a baby station. It is of hardly sufficient size for even a country town. In our experience it is far better to build a two story station having your dynamos on the upper floor, your roof trussed in order that there shall be no posts or wires projecting up from dynamos to it to interfere with the rapid moving of machines from one portion of the room to another, or the changing of armatures. As the continuity of your lights is the criterion of your success, you want to have your machines in such shape that an armature can be rapidly changed, and also that if the machine flashes that the dynamo man can get there quickly, and that that machine may not flash the second time. Flashes mean rebates, and they are very expensive things to have.

Mr. S. E. BARTON, of Boston: In reply to Mr. Law, I think the reason why Mr. Woodbury has not referred to waste and things of that sort is because he thought that was beyond the scope or intention of his paper. His purpose was to describe the method of the true construction of the station, and not the methods to be employed in the care of the station afterward. The question as to the danger of waste is purely a question of care, and gross carelessness or negligence may occur in the most modern constructed station as well as in the poorest constructed one. I do not think that that thing was out of Mr. Woodbury's mind. In fact, it is the very subject that absorbs his whole time. It is his business to see to the proper care and cleanliness of the risks which the companies that he is interested in insure. I do not think it was an omission on his part, but that he simply thought it was unnecessary to go into that part of the subject. I agree with Mr. Law that the cleanliness of the station is a very vital thing. In fact, I go further, and say it is the most vital thing as affecting the fire risk of the generating station to-day. I believe that more than three-fourths of the fires that have occurred in stations have been due to carelessness, to want of cleanliness, and little bits of carelessness in the same line as those of which Mr. Law has spoken, from spontaneous combustion and other causes. I believe further that a thing that is very sadly overlooked and not thought of in the care of central stations, is the condition of oil aside from the waste itself—the unnecessary amount of oil that is allowed to accumulate on the station floors about engines and dynamos, so that when once a fire occurs from any cause whatever the material of the most inflammable nature is there in order to spread the fire in a perfect flash from one end of the station to the other. The air and floor are filled with volatile inflammable substances from the oil. I believe it is just as easy to keep the floor of a generating station as clean as a kitchen floor. It is just as easy to do that as it is to have it saturated and swimming with oil. I believe the floors should be made of hardwood and should be kept free from oil by washing at least once a week, and twice a week, if necessary, and should be kept almost absolutely free from oil. We have any quantity of stations in that condition today, where you could scarcely soil a cambric handkerchief on the floor except from the coal that is tracked in from the boiler room; but as far as oil is concerned they are absolutely free, and there is no danger of fire in such stations. If a fire starts it cannot make any headway. When a station is constructed according to Mr. Woodbury's designs, it is slow burning anyway. There is nothing for the fire to feed upon to gain rapid headway. The keeping of a station clean by washing the floors in some instances cannot be well and safely done with the present practice, that prevails almost universally, of running wires from dynamos down through the floor, for no purpose that I can conceive of except for the purpose of bringing them up from the floor again. I know of no reason why wires cannot go direct from the dynamo overhead in plain sight.

Mr. SICKLES: I will say in regard to fire, the Cunard line of steamers ran for 30 years without having a fire, but they always had the hose stretched on the dock; that was the thing to do. The great thing to do is to have your hose ready for the fire, and if it is ready you will not have much of a fire. Fires break out, and then people say that it all came at once. You see that in the paper every once in a while; that is not true. If in all the stations you will make proper preparations for fire and sustain them, and if the superintendent will strike the alarm once in a while, and see how quickly it is responded to, you will have no fire in the station. I was going to say the fire will not dare to be in.

Mr. J. A. SEELY: I would like to ask for information in relation to the building of floors. I have not heard any opinion expressed in relation to concrete floors. I would like to know if there is any objection to concrete, and what has been the previous experience in that line?

Mr. M. J. FRANCISCO: If the gentleman will build a concrete floor and put his dynamo on it, and then try to handle the floor, he will get an illustration of what it is. In regard to Mr. Sickles' remarks about the hose, it is an old saying that "an ounce of prevention is worth a pound of cure." My idea is to put the station in such a condition that there will be no occasion for fire, and then you will not require any hose.

Mr. TORREY: Almost everything that has been said on these three papers came from men who are in charge of large plants, or owners of large plants in cities where, if a good plant is not set up in the present light of mechanical engineering there is some fault somewhere. I have spent most of my time for the past five years among the plants of our country brethren, where they do not have the facilities that you have in the cities, and the problem there, I claim, is a totally different one. I have never heard in any electric light association or seen in any literature on the subject anything that would throw any light on the construction of stations in the country. Of course a little station of 25 lights is a small thing, but it is going to grow, and a great deal of the support of electric lighting is going to come from the country. The boiler question is an absolutely different question where you have a city with a good soft water supply that comes in hydrants, and where you can have the water brought into the building, from what it is in places where the year round there is nothing to depend upon but an intermittent supply of water that is hardly fit for use in boilers anyway. I saw a station the other day of about the size that has been spoken of before, where the load runs up to perhaps 500 incandescents during one part of the evening, and along after 12 o'clock the engine was running along with a maximum load, according to the indicator, of about 27½ h. p., of which 18½ h. p. is friction load, and then in the early part of the evening when the whole load is on, the load piles up to as high as 80 or 90 h. p. Where is the economy in that? It is unnecessary to say to any man who knows anything about electric lighting, that the station has never paid a cent, and it is still more obvious that it never will pay a cent under those circumstances. I remember another station that I visited last summer, where I was requested to overhaul the engine. It was one of the very best engines, and the only trouble with it was that when it got out of order, they gave the job of repairing to any tramp that came along, and after about three tramps came along the engine was in such a condition that no mechanical engineer in creation, unless he took a whole machine-shop with him, could put it in good condition. I tried for three days to

set the valves, and it ran well for about an hour, and when I came back the next day it was just in as bad a condition as ever. No man in creation could put it in good order and make it stay. The mechanical part of electrical construction is substantially all of it. I will venture the assertion, and I can back it up by any amount of figures from my experience, that the majority of country stations do not pay, and the reason is because of the fault in mechanical engineering.

Mr. C. J. Field, of Brooklyn, then read the following paper:

DEVELOPMENT OF GENERATING STATIONS FOR INCANDESCENT LIGHT AND POWER.

I desire to present to you a brief review of the present and prospective future of central power plants in the larger cities, taking as an illustration one of the more recent types, describing its general arrangement, then proceeding to the consideration of its initial cost, earning capacity, output, operating expenses and economy, and, in conclusion, trying to indicate the immediate future development in this class of work.

Central Stations.

The immediate points to be considered and carefully weighed in the designing of central power plant for a large city are many, and they should receive careful survey before any work is proceeded with. We will briefly summarize them as follows:

First—Recognition of the importance of safety and reliability in operation.

Second—Obtaining the true economy of output under all conditions.

Third—Installing of plant in a building entirely suited to the working of same, and as far as human ingenuity can provide proof against destruction.

Fourth—Adaptability to proper and economical working of the plant.

Fifth—Division of the generating power into the proper number of units for the safe and reliable operation of the plant.

Sixth—Flexibility of system; that is, adaptation to furnishing current for light, power and other sources of revenue, the obtaining of the largest return per dollar invested, and not carrying to excess for the mere sake of engineering by any part of the plant for the obtaining of proper results therefrom.

Seventh—Not installing the plant for mushroom growth, but laying it out for comprehensive business, thereby securing at as early a date as possible the entire confidence of the invested capital.

A true and careful consideration of these points will prevent trouble later on. Much of the trouble of stations at the present time in their standing with the community is due to neglect of this point, and the majority of their failures as well. We have got to recognize the fact that the public, to a certain extent, have become prejudiced, in a measure, somewhat unjustly; but this is all the more reason for better and more conservative management and giving them good construction. No more inviting field is offered for either investing capital or good engineering than a central station for lighting, power and railway work.

A Representative Station.

I propose to take as a representative type, showing the present development and first-class work, the station of the Edison Electric Illuminating Company, of Brooklyn, which was completed last fall and is now in successful operation. With the aid of illustrations which are included here, I will give a general outline of the arrangement of this plant and apparatus used.

In the arrangement of this plant there was somewhat of a departure from previous general practice in this line, the company trying to secure the benefit of past experience in the larger stations of this class, both in the arrangement and kind of apparatus used, trying to secure at as economical a cost as possible the best plant for the purpose. As will be seen by the longitudinal section through the building, Fig. 1, the general arrangement is as follows:

The boilers and engines are located on the first floor, the engines being on the front half, and the boilers at the rear, thereby bringing everything in this part directly under the eye of the chief engineer, making it much better than where the boilers are located two or three stories up; this was obtained by spreading out a little more on the ground. The boilers are Babcock & Wilcox's largest type of sectional water tube boilers. The engines are 300 h. p., compound, horizontal, automatic engines, manufactured by the Ball Engine Company. Each engine is directly belted to two generators. The plan of the engine and boiler room floor will also show in more detail the general arrangement here used, and, I think, needs no further explanation.

Ascending to the second floor, we reach the electrical part of the plant. Here are located in the front part of the building, directly over the engine room, twenty-four dynamos, each with a capacity of 750 ampères and 140 volts. Each dynamo weighs about eight tons. Overhead traveling cranes are installed here and in the engine room for ready and quick handling of all apparatus. Through the centre of the dynamo room is located the electrical gallery. From here are controlled the workings of all the dynamos and other apparatus, also all outside lines. Everything in connection with handling, generation and furnishing of current is directly under the eye of one man in this gallery, and from which he has a general view of the dynamo room floor and the workings of the dynamo, a second man being on the floor to see to the bearings and brushes. From this gallery run all the feeders, which connect into the network of mains, covering over an area of about one and one-half miles square. The ampère meters are located on each feeder, so as to show the load in each part of the district. This plant maintains its distribution and regulation thereof by balancing within itself. No feeder equalizers are here used for feeder regulation; the uniting and tying up of the system, together with the use of the auxiliary bus effects this regulation. All circuits of this plant are underground, there being about twenty-five miles of underground conductors. These have given perfect satisfaction and reliability in their workings, maintaining to-day an insulation on the system as a whole of over half a megohm.

On the rear of the second floor are located the coal storage, water tanks and feed-water heater. On the top floor we have the offices, supply rooms and workshops of the company. Returning down stairs again, we find in the basement ash pits, smoke flues, pump room, two large coal storage vaults, giving a total capacity for storage of over 1,000 tons, air blast for forced draft and other details in connection with the steam plant.

We have, therefore, here, in a building 75 × 100 feet, apparatus and all departments complete for the generation and supply of current and power for a capacity of 40,000 lights, or the equivalent in light and power, and so arranged as to secure, as far as can be foreseen, continuous working of the plant and entire reliability in the furnishing of its current. It is only thus that we can hope to obtain a business and establish ourselves on the commercial basis which gas light companies have placed themselves in the past years, and thereby secure to our stockholders the returns for which they have invested their capital.

Having thus generally outlined this plant, we will now turn our attention to the consideration of other points in connection with it. One of the most important items is the cost of such a plant. I give you below, in round figures, the cost as shown by the construction accounts and estimates:

Station building, complete, including all fittings, foundations, stacks, furniture, etc	$100,000
Real estate	36,000
Steam plant, including engines, boilers, pumps, heaters, piping, belts, etc	50,000
Electrical plant, including dynamos and all electrical apparatus, as switches, etc	40,000
Underground system material	115,000
Excavation and labor installing same	35,000
General, including lamps, meters, tools, instruments, engineering and architectural expenses, wiring, services and office furniture	50,000
Total	$426,000

This includes the entire cost for the plant as it stands to-day, which, as far as the building is concerned, is complete for the entire capacity. At present there is installed generating capacity of boilers, engines and dynamos, for one-third (⅓) of the final output of the plant. The electrical apparatus is complete for the entire output, with a very few additions in the way of a few switches, etc. The underground lines have a capacity for 20,000 lights. The work necessary to complete the plant for its entire capacity would amount to about $200,000 additional. For this amount there has been obtained here a plant, which is considered equal, if not superior, to any of this class, and at a cost of twenty to thirty per cent. less than is expended for similar ones.

I will take up the next consideration of the operating expenses of such a plant. In order to place the company on an earning basis we have to secure to start with a certain number of lights or an equivalent in lights and power to clear the necessary general and operating expenses, which will exist regardless of the smallness of the load; in other words, we must have for such a capacity plant not less than 5,000 lights with an average income of $8 per light per year to clear the general incidental and operating expenses. This figure we may consider as our unit of operating capacity. From this we can figure the increased earnings and profits for the larger number of lights connected. There exists practically a constant ratio of variable and fixed operating expenses. By variable expenses we mean those obtained on a variation in load and increase of business. This includes coal, oil, lamp renewals and small increase from time to time in the amount of labor employed. The fixed expenses include those items which remain practically constant under varying conditions of income. A careful analysis of all the items covered in these expenses in such a station as this one, gives the following result: That the fixed expenses are seventy five per cent. of the whole, and the variable twenty-five per cent. approximately; or, in language which may appeal more directly to you, if we double our income or business, we only increase our expenses 25 pe cent. This shows that a station's possibilities and profit lie in increasing this business from the unit point.

The average income per light in stations of this class varies in different parts of the country and with different loads. We have illustrated a load diagram, Fig. 2, taken from this station, which gives you a fair idea of the changes and variations here taking place

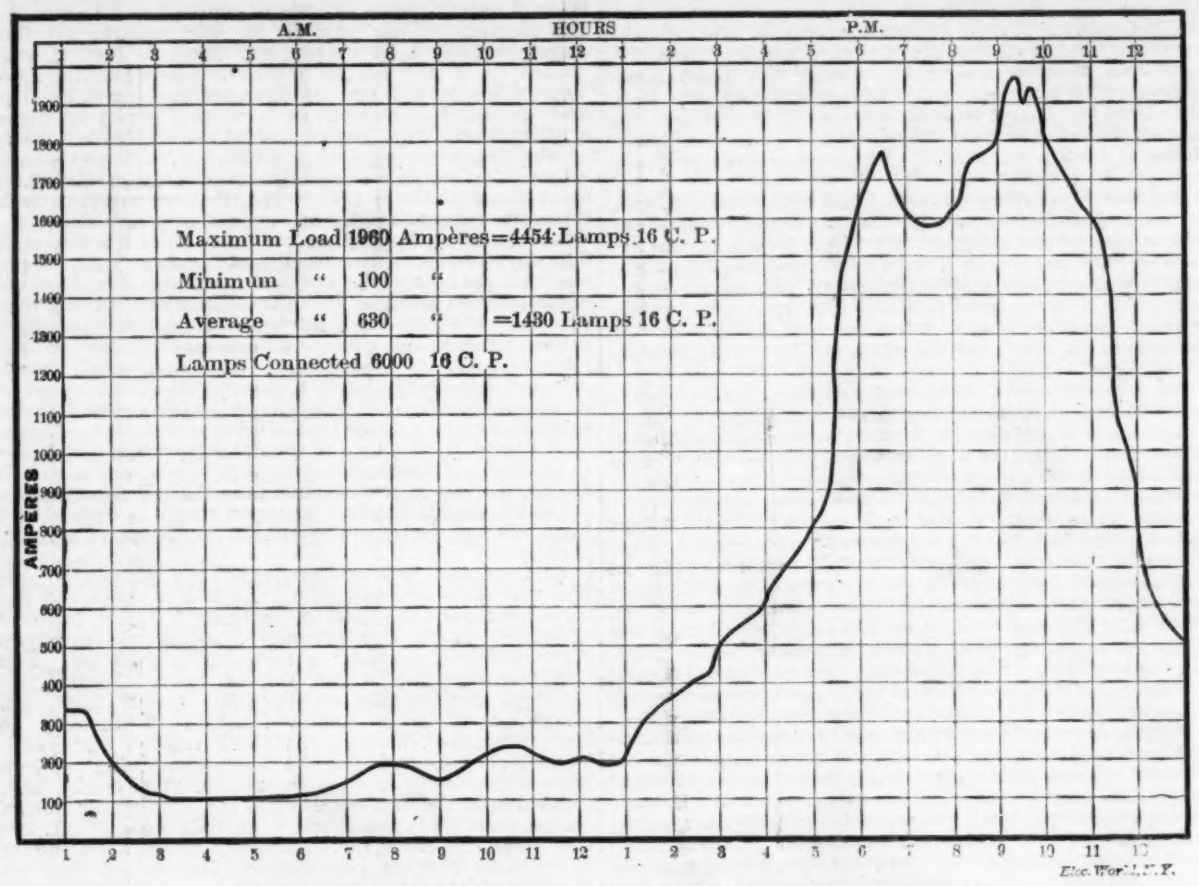


FIG. 2.—LOAD DIAGRAM OF BROOKLYN EDISON STATION.

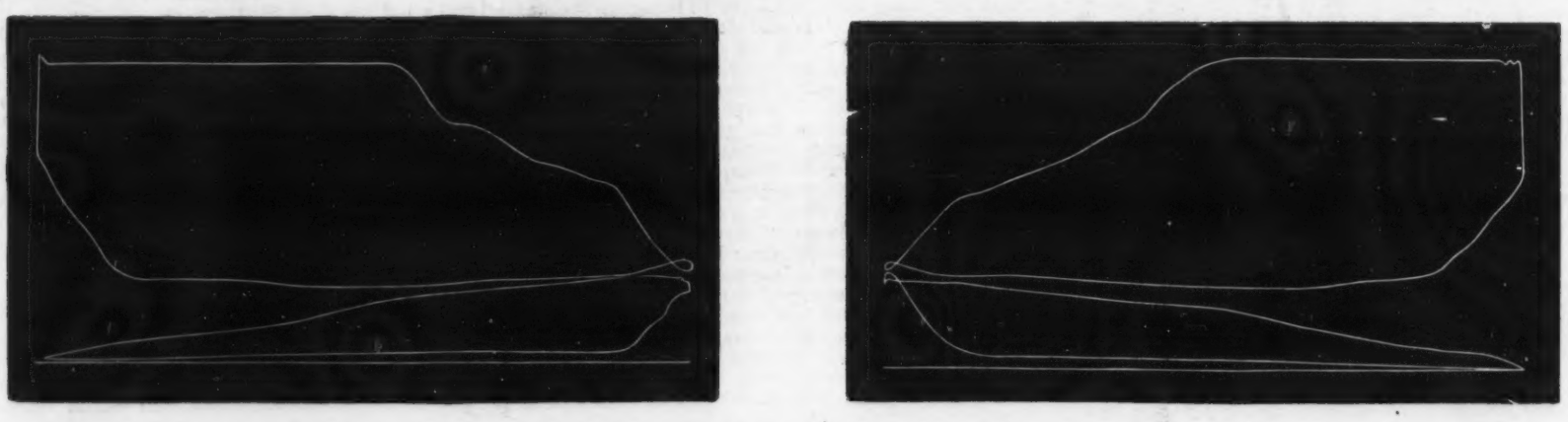
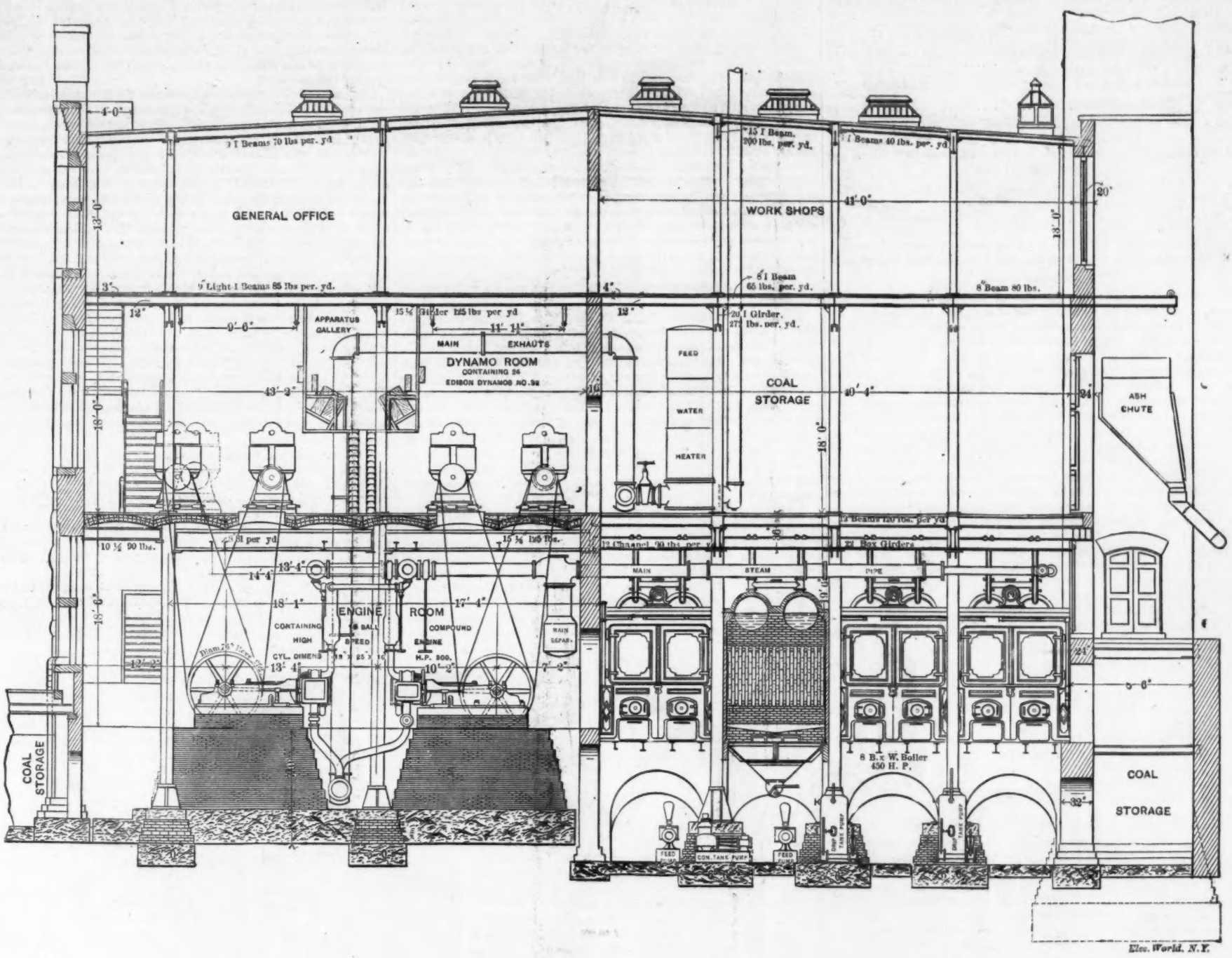


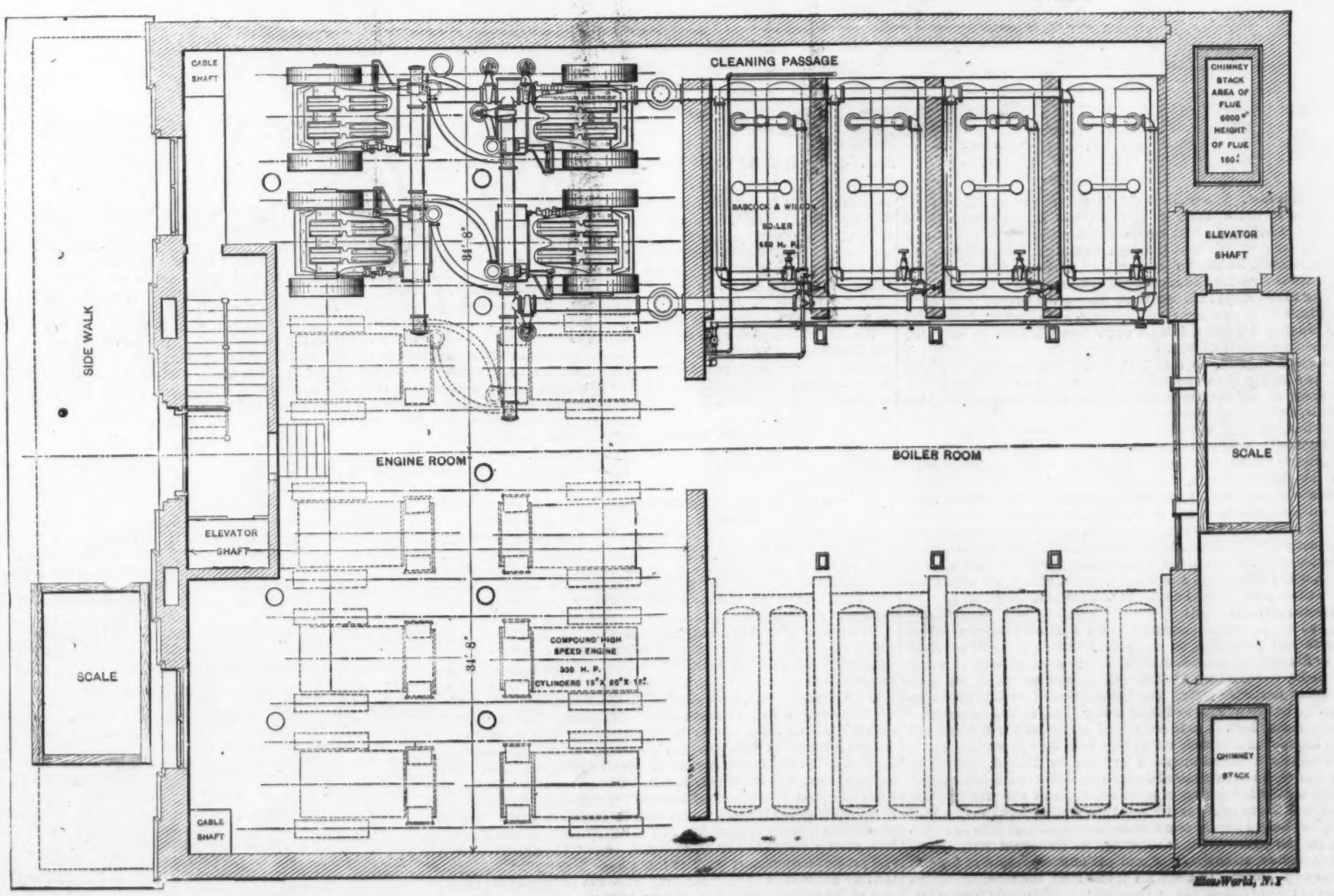
FIG. 3.—TYPICAL INDICATOR CARDS.

The maximum number of lights lighted at any time in proportion to the number connected is very good for such work and shows a good class of business. The load diagram through the day, however, shows a new station on a clear day with a small number of lights lighted, and power work only just commencing. It is this power work that wants attention, and the securing of which means the bringing up of this average load during the daytime to a good paying basis. The curve for the evening hour indicates a good, broad, solid load, which shows the comb nation of six o'clock business with the addition of a good solid evening load. Many stations after reaching the maximum point around six o'clock, rapidly fall off and never regain this point again for the evening. Here we have the illustration of clubs, theatres, churches, concerts and residences, lighting after supper, bringing up the load to its maximum point between eight and nine o'clock. The average load for the twenty-four hours, which is about twenty-five per cent. of the maximum, is a very fair one, and with the addition of the day load that will come on with the addition of power, will make this a model load diagram. The general run of stations shows an average for the twenty-four hours of from twenty to forty per cent. of the maximum load; the latter figure is very seldom reached. The writer knows of one station in which we have the latter figure, and where, if we eliminate one short half-hour around six o'clock, we have the remarkable showing of seventy-five per cent. average load for the twenty-four hours.



Elec. World, N.Y.

FIG. 1.—LONGITUDINAL SECTION OF BROOKLYN EDISON STATION.



Elec. World, N.Y.

FIG. 6.—PLAN OF ENGINE AND BOILER ROOM OF BROOKLYN EDISON STATION.

I also wish to illustrate here some remarkably fine indicator cards, which show the workings of the engines of the steam plant in this station. See Fig. 3.

The division of work shown on the cylinders is as follows:

I. H. P.	head end high-pressure cylinder	63 8-10	h. p.
"	crank end " " " "	60 2-10	"
"	" low " " "	59 2-10	"
"	head end " " "	55 2-10	"
Making a total I. H. P.		238 4-10	h. p.

with a boiler pressure of 110 pounds, revolutions 223 and load 1,200 ampères, which is the equivalent of 2,725 lamps; therefore giving for the indicated power furnished eleven and one-half lamps per horse power. This is for power developed, making no allowance for friction of engine and dynamo. The friction of the engine is less than five per cent. of its normal capacity.

Having in the above given a general outline of this plant, its cost and operating expenses, I now wish to call your attention to the points in connection with the type of engines, boilers, dynamos, underground system, etc., to be adopted in a station of this class.

Conclusions.

We will first consider the question of the engine. As already stated, in proposing the engine power of a station of this kind, we first have to consider the question of using either the Corliss or high-speed engine. Regarding the use of Corliss engines in a plant of this kind, we are frank to state our objections. Excessive first cost, ponderous machinery, counter shafting, pulleys, clutches, etc. lead us to believe that these things are unnecessary when the problem is carefully considered from an unbiased standpoint. What we are after is results; not theory, but actual practice. Assume, for the sake of argument, that we can save five or ten per cent. in steam economy; if this is obtained at a cost, the interest of which amounts to more than this, we are obtaining it for no good whatever; furthermore, there are many other problems in electric light stations which we have to carefully consider in this question of steam plant, one of which has been enumerated before, viz., the question of reliability in operation, and always being ready for service. One of the latest types of stations combining arc and incandescent, where we have the Corliss engine in all its perfection of detail and apparatus, is that of the Narragansett Company, in Providence. If one will carefully look over this plant, as I had the pleasure of doing a short time ago with others, and consider all these problems carefully, and then examine a station similar to the Brooklyn one, I think he will be forced to admit this fact. We want to obtain our power as direct from the engine to the dynamo as possible, and at the same time as cheaply, and obtain the best economy under the variable loads we are going to have. We cannot design our plant for that capacity which is reached as shown on our load diagram, for only a short time in the twenty-four hours, but we must so design it to give this result for the average that we have during the twenty-four hours. Even where we have a more constant load, as in exclusive arc lighting on municipal circuits, I think even here we need to carefully consider the problem as well.

High-speed engines, so called, although they are not in piston speed any higher than the Corliss, but merely in rotative speed, have shown a considerable development and marked advance in the past year, and the next year is going to see even more development in this line. Owing to better workmanship, better designing and building than formerly, the prejudice which largely existed among old engineers against this type of engine is rapidly wearing away. With the single cylinder engine under variable load, we often obtain poor economy, but, as compared with the Corliss, under similar conditions, allowing for the discrepancy in price, the result is not so disparaging. Now they are going further, and building compound and even triple expansion engines of this class. In the Brooklyn station we have one of the representative types of this class of engines, being horizontal, compound engines, which we here illustrate to show their general design in more detail. (See Fig. 4.)

These engines are built for high economy and economical work, and the guarantees made on them I think compare favorably with the guarantee on compound Corliss engines; at least three or four of the manufacturers of this class of engine stand ready to-day to guarantee from 22 to 25 pounds of water per indicated horse power per hour. I do not know of any Corliss manufacturers who are willing to do any better This is for non-condensing; condensing from 17 to 18 pounds of water per horse power per hour. Engines of this class are as well built now in workmanship, and as reliable in operation as can possibly be desired. Added to this, we have the advantage of direct connection to our generators, avoiding all the intricacies of shafting, etc., and the unreliability they entail. Tests made at the Brooklyn station have shown that the engines have actually come up to the guarantee made on them and that the plant there is showing, as compared with single cylinder engines, an economy of coal per unit of output of from 25 to 30 per cent. better. In a station of this kind, the actual coal consumed per unit of output at the dynamos is considerably larger than is shown in a direct test where we charge the engines only with the coal it uses directly. The weekly records from stations of this class charge the horse-power output with all the coal used by the engine, pumps, condensers, well pumps, cleaning fires, blowing off boilers, etc., and where the former item is about three pounds of coal per horse power per hour, we have in the latter case, making no allowance for the engine running empty, a result fifty per cent. greater than this. Economy in this line, however, is not going to stop at compound engines, as there are being built by at least two manufacturers, triple expansion high-speed engines. I have not been able as yet to obtain drawings of this engine, but illustrate here a type of engines of this class, which has been imported from France by Mr. Thomas A. Edison. (See Fig. 5.)

Something similar to this is what we may obtain to-day, if encouragement is offered, from such engine manufacturers as Armington & Sons, Ball Engine Company, McIntosh & Seymour and others. We are coming to a recognition of the fact that if we want the high economy we can obtain it as cheaply and as well, not to say more cheaply and better, with an engine of this class as with engines similar to those installed in the Providence station. In guaranteed economy it will equal the Corliss engine, as installed in the Narragansett station, and give it to you under a wider range, the load.

In connection with the triple expansion engines mentioned, we have to consider, again, the problem of the dynamos to be used. We can stay as at present, and belt to our dynamos, but I believe that the next large incandescent stations will not only include compound or triple expansion engines of 300 or 400 h. p., but will also have multi-polar dynamos, one or two being directly connected to the engine. By this I do not mean belted, but direct shaft connection through a flexible coupling. This, of course, necessitates the multi-polar machine, in order to secure the output with a slower speed. Engines and dynamos of this type can be installed in the space at present occupied by the engines alone. This means not only economy in building and real estate, but also in operating expenses.

In regard to boilers for such a plant, we do not know that we have any new economy to be hoped for in the near future. All we have to look for at present is improvement in detail of manufacture and the securing of better and dryer steam. We have two classes of boilers prominently before us for this work. We have, in general, first, horizontal tubular boilers, which we find in general factory use, to a large extent, throughout the country. Where we have plenty and cheap real estate, poorer attendance and moderate steam pressure, this class, in general, fills the bill. We find, however, that they are now even building them to work up as high as 125 pounds boiler pressure. When we come to construction of the boiler plant on expensive city property, where we are cramped for space, we are almost limited at once to some one of the types of sectional water tube boilers. In the Brooklyn station we are practically limited to the consideration of this class, and we have not only 125 pounds but 150 pounds boiler pressure, and even higher. We have also the advantage of quick steaming under heavy changes in load.

We have to-day brought before us in the underground systems the consideration of what is to most of the companies their most serious problem, in the proper solution of which the best talent is being devoted. In the Edison underground system we have what is generally recognized as the most practical solution for circuits of less than 400 to 500 volts. We here obtain at a premium of cost the most flexible system and local distribution from house to house, which has no equal. It enables you to take off services for local distribution from every twenty feet without in any way affecting the insulation on the main line, and being able at any time to disconnect these services and restore the main to its original condition. In any other system we have the problem of splicing and cutting of cables, which, at its best, is bad work. What we desire is not such a high insulation as good, mechanical protection. As long as we can hold a moderate insulation with good mechanical protection, that is all we want. In Paris they have used bare copper conductors, supported on porcelain in a concrete conduit. This has worked satisfactorily in the main so far, but, of course, is very expensive. They are now proposing for all their increase, the Edison tubing for this class of work. In any system of cables drawn in we have the selection of a large class of conduits, but to my mind all we need and desire, as I have before stated, is mechanical protection for these cables, and the cheapest conduit that will afford this protection is all that is necessary. What is wanted especially is some system of local distribution for these higher tension circuits. The underground system installed in Brooklyn has a network of underground conductors in the mains and feeders of over twenty-five miles. This entire system is so arranged, distributed and connected in a network that, with a drop or resistance of 1 per cent. on the mains and 10 per cent. on the feeders, we are able to maintain in the system practically a perfect regulation in the distribution of the current. This system stands to-day representing one of the most complete and perfect examples of work of this class. The largest problems that we know of in underground work are the proposed new extension of the Edison Company in New York, and the underground system of feeders proposed to be installed for the West End Railway, of Boston. The copper alone for the latter amounts to over $1,000,000; and this question of the cost of the copper calls my attention to a fact which I desire to notice, that much of this question of bugbear on copper is uncalled for when we are considering the underground system. The entire copper used on the system in Brooklyn is less than one-fifth of the cost of the underground system first installed.

I do not desire to claim that the ideas for the class of work here represented and described hold or represent all the perfection to be obtained in central station work. There are many points contrary to the ideas here outlined which are very desirable. I have merely tried to call your attention to what I consider good work in this particular line, and hope that it will result in bringing forth the discussions and additions which are very beneficial in the consideration of these problems in the results to be obtained, and I would only add a tribute to the powerful and master mind whose work, from the commencement of this field of central station distribution, has covered the leading problems and points, and whose ideas to-day represent much of the good and very little of the bad problems which we have in this work. I refer to Thomas A. Edison, whose work, commencing in this field on the old Pearl street station in New York, over eight years ago, when the majority doubted, and but few believed in, its successful carrying out, and while we find that station, until within the past few months, when it was partially destroyed, successfully working, and even, antiquated as it was, earning large dividends. He has still continued actively to impregnate his ideas on the work from that day to this although he has not taken such an active part in its carrying out, but I think we may see him at no distant day again taking a hand in this work, and bringing forth many new ideas in advancing the progress of the future.

Mr. DeCamp: I want to ask Mr. Field one question. I think in the early part of his paper the statement was made that the fixed expenses of the station were 75 per cent. and variable expenses 25 per cent.; may I ask just what is meant by "variable expenses?"

Mr. Field: Variable expenses are coal, lamp renewals, any increase in oil and any addition to the labor account.

Mr. DeCamp: I presumed that was about it. Do you not keep an extra pay roll?

Mr. Field: No, sir. If we double our output, of course our pay roll would increase to a certain extent.

Mr. DeCamp: My understanding of it is that your fixed expenses were 75 per cent., and your variable expenses 25 per cent.; and I inferred that was the actual fact. But there are what you term "variable expenses." Of course there is an average on which you make them up.

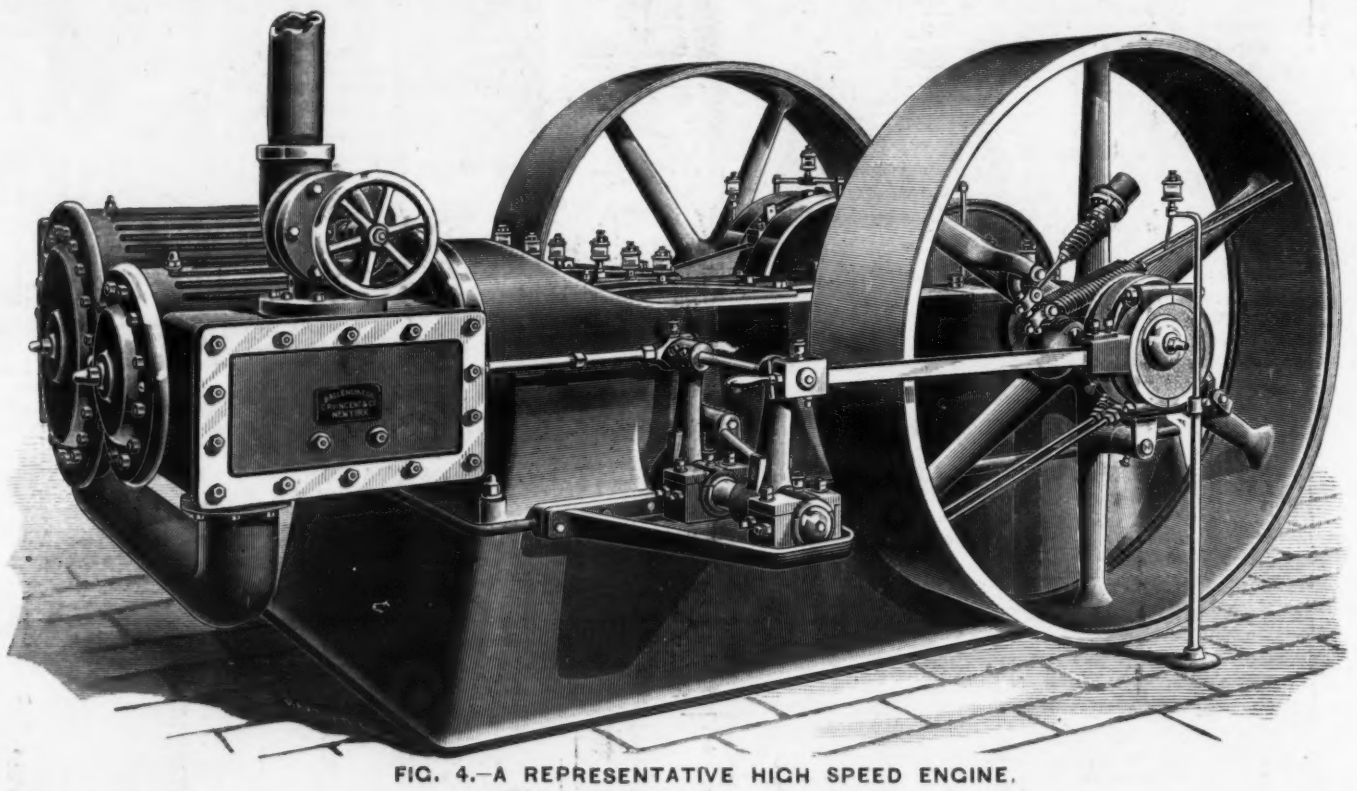


FIG. 4.—A REPRESENTATIVE HIGH SPEED ENGINE.

Mr. Field: These are based on 5,000 lights connected, and are based on actual facts. But the labor account for that number of lights connected goes into the fixed expenses. There is no variable labor account, or extra labor, or anything of that sort, if that is what you refer to. This is for 5,000 lights connected. We have 100 per cent. operating expenses, of which 75 per cent. is independent of the number of lights connected; and if we double that number of lights connected, making it 10,000, our operating expenses will increase approximately 25 per cent. I recognize the fact that estimates will vary in different stations, and to a different extent, according to their management and the way of working the operating force, etc.; but it is about the figure in stations of that class.

Mr. DeCamp: I think that the theory—because I believe it is a theory—of the increase of expenses, the ratio of increase to expenses, is not properly appreciated. I believe the ratio of increase to the ratio of expense is very much greater than it is generally supposed to be. I have had a little experience in that direction, and I draw my conclusion from that and from considerable observation.

Mr. Field: I have not drawn these conclusions from one station, or from theory. They are drawn from facts as they are represented, and facts as represented in a large number of other stations of the same class, based on actual results in them, in different lights, at different times, in their history.

Mr. A. P. Seymour, of Syracuse, N. Y.: Mr. Field has covered the ground very thoroughly, I think. I am hardly prepared to discuss this matter because my station is an arc light station. But it seems to me there is one rule that can be applied to all localities. That is to say, in different localities you cannot apply any specific rules, but there is the rule of using common sense, which can be applied everywhere and under all conditions, to great advantage. Another rule that can be applied everywhere, is to do your work well. If you can't afford to do it well, don't do it at all. If you start out under the rule that you must do your work well regardless of expense, you are sure to get economy and good results in the end. In our station we are using Corliss engines. We used to use high speed engines, but we took them out

and put in the Corliss engine, and we have found that our saving was about 52 per cent. in fuel. Of course we are in favor of the Corliss engine. Our conditions, of course, are different than they would be in an incandescent station.

Mr. J. F. MUNSIE, of Brooklyn, N. Y.: I desire to ask Mr. Field a question. You claim that the Edison is the best for distribution?

Mr. FIELD: I said for certain classes of work.

Mr. MUNSIE: Well, for electric lighting distribution?

Mr. FIELD: On low tension circuits.

Mr. MUNSIE: Individual circuit distribution? We have on exhibition here a system of underground conduits, which I think will clear up that assertion without any more talk, and one which I think all the members of the association should examine.

Mr. E. A. ARMSTRONG, of Camden, N. J.: I understand that Mr. DeCamp said that he proposed to discuss this increase of cost in a paper he had. If not, I would like to ask Mr. Field a question. The matter of cost is a subject I am largely interested in.

Mr. FIELD: When you come to make your estimate for the increase of capital to increase your plant, for your plant is capital, the question will arise, What are going to be the terms? If you base it on what I term and I still think is largely theoretical, that the output of capital will give you an increased income at such an increased expense, that can be ascertained approximately. I think there are a great many mistakes made in that direction. I do not think there is a single portion you can figure down in a single plant.

Mr. ARMSTRONG: It has been suggested to our general manager, and I recommend it to our Board of Directors. We now understand our expenses are so much, accepting the figures that Mr. Field suggests, say, 75 per cent. In other words, assuming we were only earning enough to pay our cost, we were simply paying our way. I suppose by the expenditure of a little more of that which he has termed "variable expenses," that I could get a very large return, and I could double my receipts. I could double my revenue by an increase of say 25 per cent. in my expenses; that was my understanding. If that is not so, then it seems to me that electric lighting is rather a peculiar business. Of course, I do not profess to know anything about electricity, or much about the mechanical part of it. The only thing I am particularly anxiously looking for is the dollars and cents; that is what I am in the electric lighting business for. I am not a scientist: I do not profess to understand anything about that, but it seems to me that this is going to be one of the great businesses in the future. This association represents one of the great businesses of the country, and therefore this point is something that we ought to have particularly cleared up. I am more pleased with this paper than anything I have heard here at the convention. It seems to me, from my standpoint, one of the most practical things we have had presented.

Mr. FIELD: I have assumed that in increasing your outlay your capital is going to increase proportionally, and that you will not add a debt which you must pay interest on. The question of that proportion will be found in the class of work which I have outlined here on incandescent stations. I know stations, which I could give by name, where results are actually obtained, and where many of them have gone on the false idea that has been prevalent for several years, working just on the borderland, having a good business, had not had the capacity to increase their business, or, lacking management, where no increase of plant has been made, but where an increase of plant would have been followed by good results to the station and directors and stockholders. It is a proposition you have got to meet. You must get to business. You cannot go on the borderland. You must do the same as the gas companies, and you will cut your operating expenses down to the small figure to which they have reduced theirs, compared to their income. It is only in that way that you will get the good result in your pay roll, in your labor account and all these points that I have tried to outline. They are all very largely dependent on your business, on your plant.

Mr. P. H. ALEXANDER: I want to ask Mr. Field one question. He made one remark in his paper, that within five months he had but one cross that they blew out, by which I suppose he meant that they burned it out. I want to ask this question first, whether the third wire was grounded, and secondly, whether he considers it safe to blow out a cross? I think if you do that you increase the danger of electric lighting considerably.

MR. DECAMP: That is a very effective way of finding it.

MR. FIELD: That is treading a ground that I do not think has been thoroughly settled in the question of grounding the neutral wire on a three-wire system. It is a question that has not yet arrived at a solution, yet it is a thing that has to be left to the individual judgment of each manager. It varies in different systems. You strike some old systems where they practically have not grounded their neutral wire, owing to defects in their underground system. They have done that to avoid a cross between their two outside wires, as by grounding their neutral one, to come in between their positive and negative—when the "ground" wire attempted to come in between the positive and the negative, they would blow that off. In answer to the question Mr. Alexander asked about blowing off the ground, I think it is like this: When you get a heavy cross on your underground system, what are you going to do? It is going to do mischief, and you have got to shut down or blow it off; that is all there is to it. I do not think you are taking any chances, that is, any great chances. I have seen a good many blown off, and I never knew them to give any trouble. They will make the lights shake for a few minutes, and then you will go on serving your customers, just as you did before, and take your time to hunt it up.

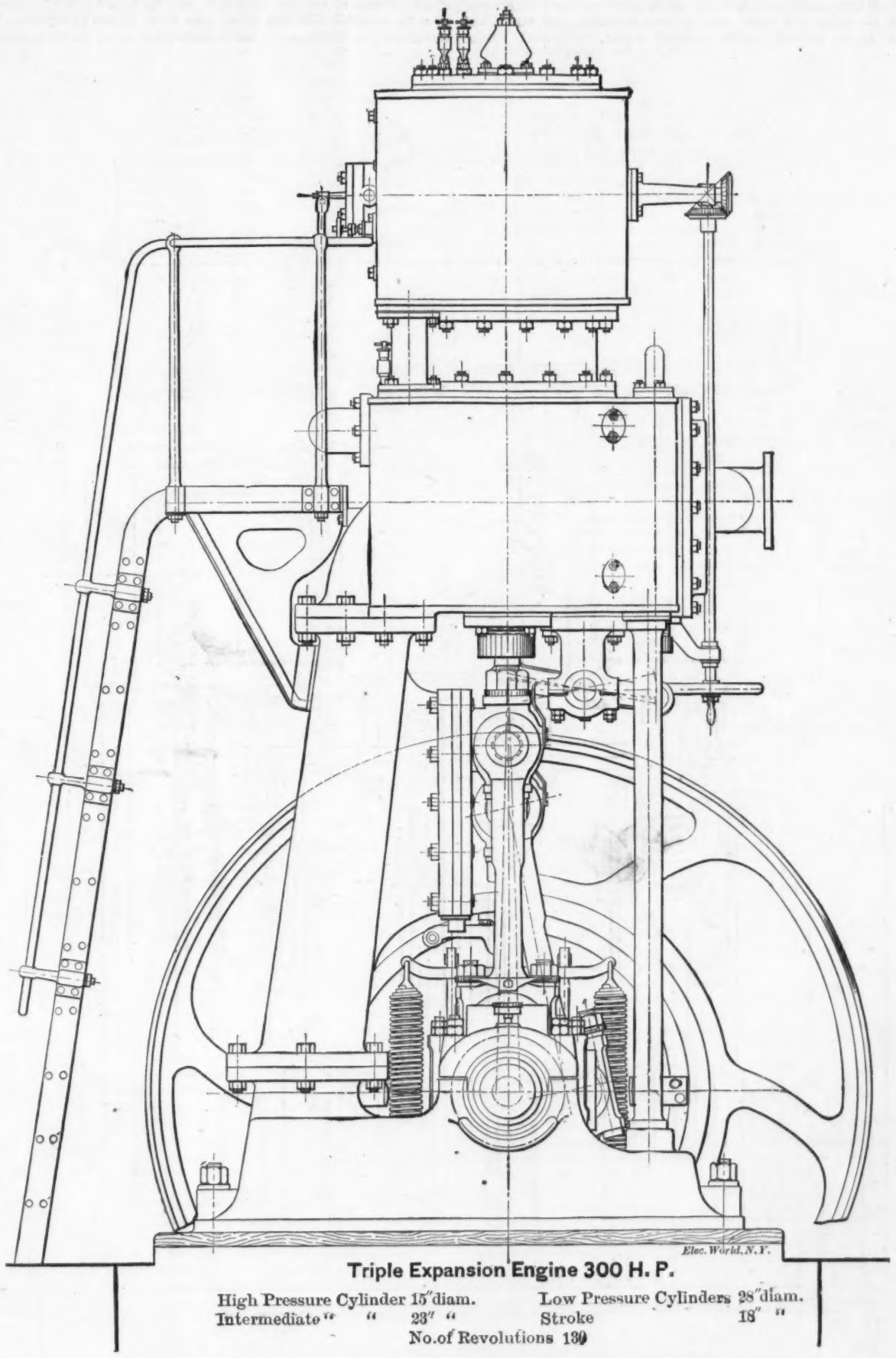
Mr. DECAMP: I once sent $2.50 in response to a circular of a gentleman who advertised a perfect way to find mistakes in a trial balance sheet. I got his rule, of which there were five or six columns, but there was a note following that wherein he said, "If this don't suffice, hunt for it." (Applause.)

The following paper was then read by Mr. T. Carpenter Smith:

A UNIVERSAL SYSTEM OF CENTRAL STATION ACCOUNTS.

Having asked, and been asked, many times as to the cost of producing electric lights, and having received and given answers which varied widely, without having any means of reducing them all to a common denomination, I have thought that some system of doing work and keeping coat, might be devised which could be used in stations of any size, and at the same time enable us to make fair comparisons between them. To do this it means that we ought to have some general principles of doing work, and carrying on the routine duty of the station, which principles should not be burdensome to stations of small capacity, but the details of which could be elaborated as the station increases its business, until it should fairly result in a company being able by a simple inspection of its books to tell what it costs to do its work from day to day, and on just what items of its business it was making or losing money.

We all know that in the electric light business there are certain contracts which must be taken and which must be done, from which no real return can be expected, and the problem is to know just how much we make or lose on each particular contract in order to decide quickly whether the "game is worth the candle" for such cases. To find what is necessary to be done in the highest development of this method, I think the easiest plan will be to describe a system organized some years ago, which has stood the test of time and service, with the need of but few changes. I do not wish to be understood as claiming that this system presents any great originality, since the most of it is only the application of methods of carrying on business which have been worked out from time to time. The application of some of these methods, however, to electric light station work is, I believe, new.



Triple Expansion Engine 300 H. P.

High Pressure Cylinder	15″ diam.	Low Pressure Cylinders	28″ diam.
Intermediate " "	23″ "	Stroke	18″ "
No. of Revolutions	130		

FIG. 5.—TRIPLE EXPANSION COMPOUND ENGINE.—SIDE ELEVATION.

The first main principle is dividing the staff into two distinct branches—the station and the office. This may not seem practicable in small stations, but would explain that this has reference simply to the official capacities of the men.

In small stations it is very likely that one man will be a sort of "Pooh Bah" who fills many offices, but the lines of duty must be kept clearly distinct from one another. Without doubt all companies have been more or less annoyed by the continuous waste of time and money from customers sending complaints to the station or having little odd jobs attended to for which they never think they should pay. For such service it would cost the company more to collect the money due than the whole affair is worth; at the same time one does not want to run the risk of offending an otherwise good customer by refusing to do an apparently trifling service.

By separating the office from the station, and having all complaints sent to the office, it simply makes it not quite so easy for the customer to demand anything of this kind, and any employé of the station who is doing work in a customer's establishment has for an answer to any request to do something outside of his regular duty that he cannot do it without an order from the office, at the same time saying that no doubt it will be all right if the customer will make proper application. The office can very easily when such inquiry is made, volunteer the suggestion that the work will cost but a trifle, not more than so many dollars and cents, which gives the customer at once to understand that he is expected to pay for it, and the customer who bargains is lost.

The office under the direction of the secretary or general manager, and their subordinates, makes all contracts, orders all supplies, and receives all complaints; in fact is the only communication of the company with the outside world. The station under the superintendent, or chief engineer and his subordinates, does all work, and is responsible only to the office, and has nothing to do with any one outside of the company.

The second principle is, that no work has to be done, except on a definite order, and all supplies used, all men's time, and all expenses are to be charged to this number, without any reference to what kind of job it may be on. Duplicate books are kept in the office, and in the superintendent's office at the station, in which the orders as they are determined upon are entered in regular routine, and the men working upon them do not need to know in the least who is to pay for the work, or in whose name it is being done; but all orders, requisitions, bills, etc., are charged to order No. "X". Any man doing work for which he has not written authority, and a proper number to charge the same to, is not paid for the work, and then men will very soon learn that this system will save an immense amount of time and trouble to themselves.

The third principle is, that all supplies must be received and issued by the store-room; whether it be a new engine or dynamo, or a sheet of crocus cloth, the store-room must have the proper orders and receipts for such issue.

These principles being established, and the station ready to start, let us see what the first operation would be. A new order book being opened, order No. 1 made out in the office of the company would read: "Operate boiler room." No. 2, "Operate engine room." No. 3, "Operate arc apparatus." No. 4, "Operate incandescent apparatus." No. 5, "Operate power plant."

These orders would practically cover the running of the station if it be desired to itemize as is shown above. Where it is not de-

sired to separate the cost of each of the plants, the whole might be classed under one order—"Operate the Station."

A contract, say No. 7, being made with a customer by the office, and the exact amount of work to be done by the company entered upon the form of the contract, the customer's signature is attached. A copy of the contract, detailing the amount of work and supplies to be furnished, is attached to a blank form, which is sent to the superintendent, and which is headed "General Order No. 101," and might read "Wire up John Jones' store for 60 incandescent lamps, as per terms of contract No. 7, hereto attached."

When arranging to make this contract the office may have found that they have no pole line extending up the street on which this customer's store is located, and they will therefore have to make arrangements to build this pole line and run the wire up to reach him; at the same time they may find they have reached their limit of load on the various machines in the station. As the building of this line would probably give them a number of other customers upon it, they decide that they will at once proceed with the placing of a new 150 h. p. engine and dynamo for it, and they accordingly proceed to order the new engine and dynamo and make out two more orders, which might read: "General order descent wires up Twenty-first st. to corner of High. All materials and labor to be entered up on this form.

General Order No. 102.

Also a third order to the Chief Engineer."

"*Mr. Blank, Chief Engineer:*

Set up new 160 H. P. engine in engine room, and make proper connections to steam line.

General Order No. 103."

If it is desired that this last work should be done by contract, the superintendent, it will be observed, can make this order, instead of to his own chief engineer, to any contractor he may desire to employ; but he would make his order read: "Set up new 150 h. p. engine, etc., as per contract hereto attached," and would then have a regular contract drawn and attached to this form, which would still keep Order No. 103 as the one to which all expenses, etc., are to be charged.

Following out these three representative orders, we would say that each foreman carries a small foreman's order-book, with the leaves divided into two parts. Any order written on the first half of one of these leaves for materials will be honored at the store-room by whoever presents it, as long as it carries the foreman's signature, and the foreman, for his own protection, writes a duplicate order on the stub, which he keeps. These orders form the storekeeper's voucher for all material issued, and the foreman who issued the order becomes responsible for the material as soon as it has passed the counter of the store-room.

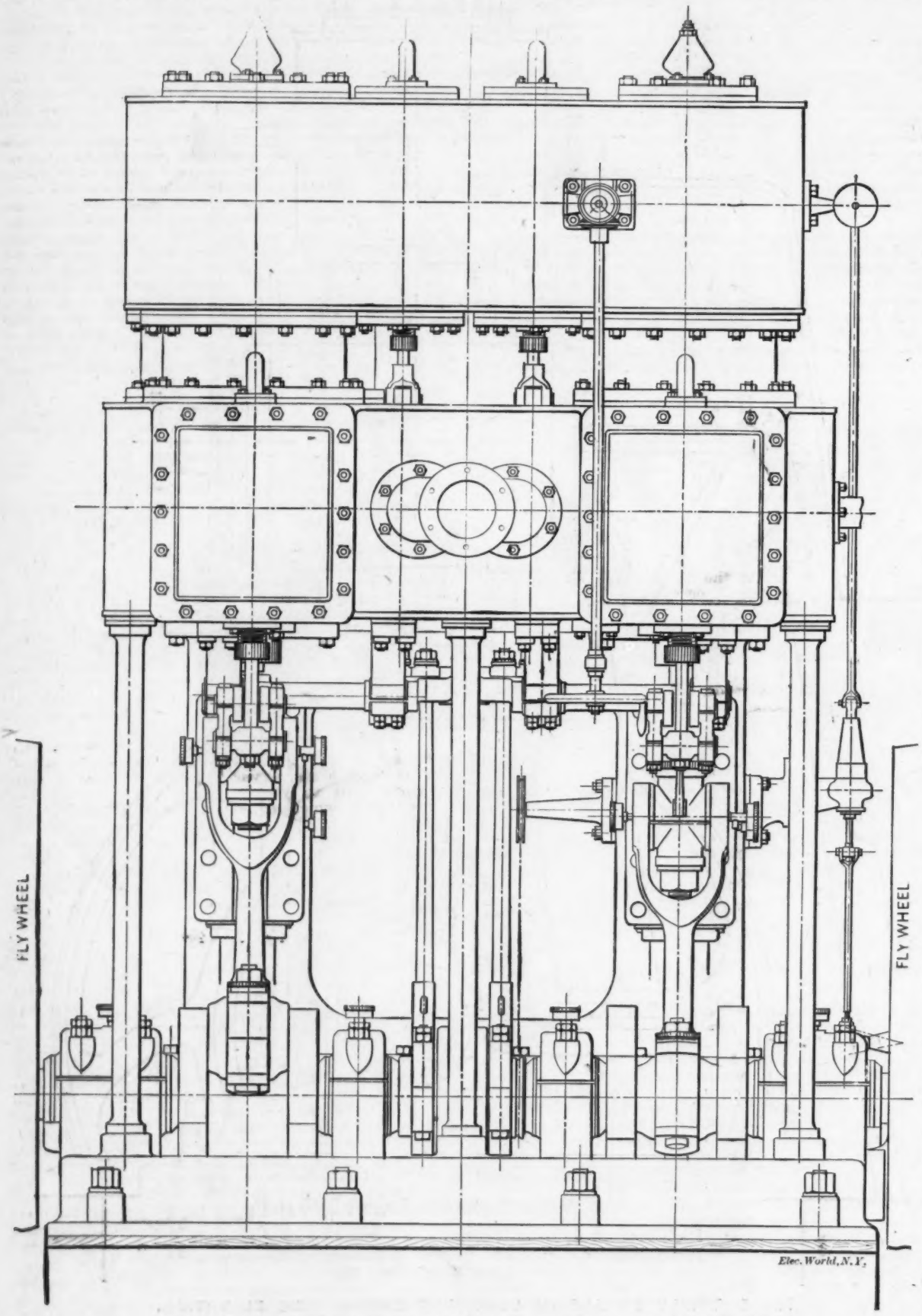


FIG. 5A.—TRIPLE EXPANSION COMPOUND ENGINE.—FRONT ELEVATION.

No. 102. Build pole line and string arc and incandescent circuit on Twenty-first street, corner of High, and "Order No. 103: set up new 150 h. p. engine in engine room and connect it with the main steam pipe." The other orders for setting up the dynamos and connecting to switch-board would follow in a like manner.

These forms, signed by the secretary and general manager, are the superintendent's authority for proceeding with the work, and he proceeds to fill out other forms which he delivers to the proper foreman. In this case these forms would read:

"Superintendent's Office.

To Mr. Blank, Foreman Incandescent Wiremen:

Do the following work: Wire up Mr. John Jones' store, etc., as per slip attached hereto. All labor, material used to be entered up on this form.

General Order No. 101."

This is placed upon the proper book for the incandescent foreman, and constitutes his authority for all labor and supplies. The superintendent would then make out another order on the foreman of linemen, as follows:

"*Mr. Blank, Head Lineman:*

Do the following work: Extend pole line, and run arc and incan-

It is found very convenient to have those "foremen's order-books" printed on different colored paper for the different departments.

The firemen, engineers, dynamo tenders, trimmers, etc.—in fact, all who are employed on the regular routine work of the station—each receive a number of numbers from the foremen of their department, to which they charge their time from day to day, according to the hours spent on each separate item.

The bookkeeper in the office, as soon as an order is entered in the order book, and the proper orders sent to the superintendent to have it carried out, opens an account on his ledger with this order number, to which account are charged all material, supplies, etc., to be used, whether the company is to receive any money for the services or not.

When the foreman in charge of the work reports the order completed, the superintendent returns to the office the original order which he issued to the foreman, which has entered upon it all material, labor, etc., used, after taking a press copy in a letter-book, which he retains as his record of the cost. The ledger account is then closed up, and the company knows precisely what this work has cost them. If they are to be paid for it, it forms a basis for their bill; if they are not to be paid for, it lets them know how much money they have sunk in their construction account for this particular item.

This system of numbering orders does not extend to the accounts of the company, as entered in the ledger, except that in entering up accounts in the ledger it may be convenient sometimes to use order numbers for entering up items in an account; such, for instance, as, if the company should have an account with John Jones as a customer, in John Jones' account it would only be necessary to say, "Construction as per general order, number so and so," and the items of the bill can then be taken directly from the order, which had originally been given to the superintendent, and which he would have returned to the office, with items of material and labor entered upon it.

While electric light companies should undoubtedly endeavor always to get rid of construction work, and simply sell current of a certain voltage at the customer's premises, up to date and for some time to come they will probably have to do a large amount of inside work. In such cases the superintendent's order, returned with the material and labor items as above stated, can be filed directly with the contract, and in case of any question being raised by the customer as to what material belongs to him, or to the company, a simple reference to the file will give this information.

All work, of whatever kind done should be charged to some account in the ledger, and a convenient division of accounts to which items should be charged will be found to be as follows:

Construction.—All pole, wire, insulators, cross-arms, and other material used in the construction of lines, whether overhead or underground.

All fixtures, cranes, sockets, or wiring for incandescent lamps; and in general everything attached to customer's premises, including any tools used for this work.

Machinery and Fixtures.—All dynamos and parts of same; belting, station instruments and switches; and all other movable apparatus in the station.

Motors.—Where the company own such.

Office Fixtures and Furniture.—Including all furniture in and about the station.

Station.—All real estate, buildings, engines, boilers, foundations, pumps, piping, shafting and any fixed scales or machinery.

Patent and Legal Expenses.—Of every nature and kind.

Store Room.—All material and supplies of whatever kind to be charged to the several departments as issued.

These various items should be, of course, considered as unavailable assets.

In what are known generally as the "Expense Accounts," a convenient division will be found as follows:

Advertising.
Carbons.
Fuel.
Insurance.
Interest and Discount (if any).
Interest on Bonds or Mortgages.
Lighting Supplies.—Including incandescent lamps for renewals, shades, globes for arc lamps and dynamo brushes and other material of this nature.
Machinery Repairs.—All repairs to dynamos, armatures, station instruments or switches, arc lamps or parts of same.
Maintenance Repairs.—Being repairs to poles, lines, etc., converters in service, metres, and other appliances used or located outside the station.
Shop and Station Repairs,—repairs to buildings, boilers and engines, piping, or any fixed machinery.
Printing and Stationery,—of every kind and nature.
Salaries,—to the officers of the company.
Wages,—of the employes to be divided proportionately to each department, as explained above by the system of order numbers.
Oil and Waste,—of every kind.
Taxes,—of every kind.

Of course, many of these items can be put together under one head if desired. The extent to which the various accounts are to be itemized is a question for the decision of the company; but it must be remembered that in work of this kind the more that is done in the way of saving labor by having the books and forms printed, the less there will be left to fill in by the employés, and the more chance there will be of their doing so correctly.

Especially should this be taken care of in arranging the forms for line foremen, since it is often very inconvenient for these men to fill out their forms when out in wet or dirty weather. A convenient arrangement for this purpose is to give the man a leather case, which will just hold one of the superintendent's orders when doubled through the centre, and an indelible pencil with which to sign their orders on the storekeeper.

The only other account which is kept separately is the storekeeper's account. He should have what is practically a ledger, in which he enters up, on one side of the page, all material received to the debit of the store room, and on the other side all material issued to the credit of the store room. He can thus have a page to each item of supplies, and having a column for the amount in stock: deducting as he issued each order, the amount of the order. He can tell at a glance how low his stock is running, which enables him to issue a requisition on the office and have the material ordered in time to prevent running out, and insert return items.

In order to prevent the necessity of foremen sending in three or four orders for small lots of material, it is better to have a system of returning material credits, so that a foreman who requires five or six hundred feet of wire can give his man an order on the store for a reel, the weight of which is taken when it leaves the store-room. The work being completed, the balance of the wire can be returned to the store room, and the storekeeper makes an entry on the stub of the order remaining in the foreman's order book, crediting him with so much material returned, and makes, of course, a corresponding entry on his report of the office.

In the same way any material which is taken down and returned on the conclusion of a contract is returned to the store room, and credit given for it. If the material is simply to be counted as scrap, it is sold, or set aside for sale, and entered up in the store-room book in that way; but should the material be fit for other use, such as cranes for arc lamps, etc., they can be simply entered up as returned tools.

An excellent plan is to have a record book for all material, etc., in the station, the engines being distinguished by numbers; the dynamos ditto, and all converters. The location of the engine is entered in the book, and the duty which it is doing and any repairs made to it are charged up against it in this book. This may not seem of much importance but in the case of converters, arc lamps, meters and such materials, it will be extremely valuable in keeping track of them.

Cases have occurred where converters have been removed from buildings when repairs have been made, and have been lost sight of for months; but a book of this kind enables them to be traced,

since every change of location or repairs are entered in the book, consequently it is easy to follow them through their wanderings. Not only this, but it occasionally happens that one gets a lamp or something of that kind which is absolutely bad, that is, it seems to be perpetually needing repairs, and it may be that in such case it will be a good deal cheaper to simply consign it to the scrap heap and get rid of it entirely. In such cases the one which takes its place can be known by the same number, and it will make no difference in the correctness of the record, since the fact that this is a new lamp will be found recorded on the page of the book devoted to that particular number.

In order to enable accounts to be kept correctly in the ledger there must be, of course, some regular division of duties, which the men themselves should thoroughly understand in order that in charging up their time they may be able to charge the proper number of hours to the proper accounts. In a large station, moreover, there must be, and will be always, a certain amount of jealousy between the different gangs of men, and there is very apt to be some clashing owing to fancied encroachments of one gang on duties properly belonging to another. Arising as this generally does from an entirely mistaken notion, it is all the harder to combat, and the best way is to prevent it arising at all, if possible.

The division of duties, somewhat as follows, may be found of some assistance to this end: The superintendent is in full charge of the station and all work done by the company of any kind or description. If the station is large enough for the superintendent to require assistance in his duties, he should have a man who can attend generally to the making out of his order, examining reports, etc., so as to take as much of the routine work as possible off his hands. In this way, during the superintendent's absence, his assistant (who need be little more than a clerk) immediately takes his place, and while he may not be able to decide just how any particular piece of work should be done, he can often decide whether it shall be done at all or not, or whether it shall wait for the superintendent's return.

Under the superintendent comes the chief engineer, chief dynamo man, chief lineman, and chief incandescent wireman.

Under the chief dynamo man come the various dynamo runners; although the chief engineer may also be able to take charge of the dynamo room, in which case it would be made a department, so to speak, of the engine staff.

Under the chief engineer come all the engineers, foremen, coal handlers, etc. In the absence of the chief engineer the engineer on watch takes his place, and the same with regard to the dynamo man.

The chief lineman should have under his care all pole lines, and outside construction of all kinds, including all arc lamps and all high-tension wires of any description; also, the care of converters to the first cut-out on the secondary side. He should also have charge of the carbon setters and arc patrolmen.

The chief wireman should have charge of all inside wires in buildings where such are under the control of the company, the care of all lamp renewals, incandescent patrolmen, and generally of all material and work from the first cut-out on the secondary side of the converters.

The storekeeper, of course, has his own duties separate from all of these.

The only reports necessary to be made will be found to be the engineer's log, for which there should be two books provided, one for the day run and one for the night run, to be filled up by the engineer on watch and turned in to the superintendent's office every morning for examination. In this should be entered the amount of coal burned, at what time each engine was started and stopped, and the other usual items; the name of the engineer on duty, etc.

The dynamo room log should be much of the same style, but include a reading of the load on each machine, taken at 20-minute intervals throughout the whole run. This report, with the amount of coal burnt, gives an excellent check upon the fireman, and on the quality of the coal.

In one station, which is purely incandescent, this record has been so well kept that it has been the means of saving the company hundreds of dollars, since any perceptible increase in the amount of coal burnt per ampère hour, as shown by the engineer and dynamo room reports, is blamed at once upon the coal. This has resulted in several instances in the detection of a poorer quality of coal being furnished, when the firemen using the coal were not able to detect the difference, but the coal dealers on being taxed with the matter fully owned up.

The various inspectors and patrolmen should fill out a printed form, giving the number of arc lamps on the circuits they have charge of; if any of these lamps are out or burning badly, and between what hours, and the probable cause, as far as they can judge.

It will be found much cheaper, however, to keep constantly on hand a few lamps, known to be in good condition, and wherever an arc lamp does not work correctly, to take it out at once and bring it to the station for repairs, rather than let the inspectors attempt to fix it in place.

The storekeeper should make a report daily of all material received and issued, which report can be used by the office as a check upon bills received for material; since the bills will be laid away until the storekeeper's report shows that the material ordered has been received and in what condition, and if any expenses have been incurred which should be charged against the bill. The use of forms for all these various purposes will make the actual bookkeeping of the station very simple.

If the company is fortunate enough to be in a position to simply sell current and nothing else, their cost accounts will really be the bulk of their work. Should they, however, have to sell arc lights the matter then becomes a trifle more complicated. The customer's account and bill will always be made up from his contract, renewals of lamps being charged up against his account as he receives them, unless the company furnishes renewals, in which case, however, it is well to keep a record of renewals made, in order to put a check upon any excessive breakage. In some cases, the customers who receive renewals for nothing have been caught supplying a customer, who had to pay for them, at half rates; or boys will bring in broken lamps for renewals from customers who are not entitled to them, giving the name of a customer who is, in order to get them for nothing. A convenient check upon this latter scheme is to have a small stamp to mark the butts of lamps were it possible, or to have some secret mark upon the lamps to find whether they are issued from the company's office or not. This little device in one station has resulted in finding two or three people who made a regular practice of this kind of business, which, of course, was all dead loss to the company.

The forms for all these accounts will be found to vary very greatly, according to the amount and kind of business the company is doing.

If a sufficient number of members of the association think well enough of this method of keeping accounts to agree to use it, if it shall be put in workable shape for them, I shall be pleased to get up such a system of forms and furnish them to them. In many cases it is the amount of detail required to think out and work up such forms that prevents their being adopted, where if they could be obtained for use they would be gladly used.

Secretary A. V. GARRATT: A letter was sent by Mr. Fred. H. Whipple, general manager of the St. Louis Exposition Company, which has gone to the New York office. Its purport, however, I learn, is this: The St. Louis Exposition Company has requested the American Institute of Electrical Engineers, the National Electric Light Association, and the electrical fraternity at large, to each one appoint one committee of three. This committee will pass upon the awards of merit and the medals to be given at the St. Louis Exposition. I have just received a communication from Mr. Ralph W. Pope, secretary of the American Institute of Electrical Engineers, that Prof. Hering had been named by the American Institute as its member. It now devolves upon this association to name its member.

Mr. PERRY nominated Mr. Edwin R. Weeks, of Kansas City, as the representative in behalf of the National Electric Light Association, and he was unanimously elected.

The convention then adjourned till 2:30 P. M.

AFTERNOON SESSION.

The convention was called to order by President Weeks, who introduced Mr. De Camp, of Philadelphia, who addressed the convention on the subject of the cost of products to central stations as follows:

Mr. DECAMP: I have a few copies of the form of a statement here, which I did not bring for the purpose, but probably it will facilitate matters if those who are interested in following the course of what is said will look at these sheets and take part in the discussion.

The following is the form in which we endeavor to record cost of products with us:

Revenue: Average Cost: Average Revenue: Lights: Other sources: Total Revenues, less rebates, etc.

Expenses.

Pay roll: Electrical department; motive power; office. General stationery, cartage, expressage, horses, tools, miscellaneous. Taxes, licenses, etc.; interest; extraordinary. Total general expenses: Coal, carbons. Engines: Oil (machinery), oil (cylinder), waste, belts, shafting, miscellaneous. Boilers: Furnaces, tubes, piping, pumps, miscellaneous. Dynamos: Oil, waste, belts, brushes, armatures, commutators, segments, miscellaneous. Lamps: Spools, cut-outs, armatures, carbon holders, carbon rods, insulations, globes, miscellaneous, incandescent. Line: Poles, wire, miscellaneous. Net Results. Previously Reported: Total for the year, Daily Average (Sunday excepted); Sunday average; Total Hours burned, average.

I will say that this is a method which has been in use with our company since the 1st of January, 1886, without practically any change. That it has been in use that long is owing to the fact that I have not myself been able to devise any better method of arriving at conclusions; nor have I seen any form adopted by other companies that I thought answered the purpose any better. I was practically without any method of arriving at the result, from the time we started in the summer of 1884, up to the first of 1886; and then it occurred to me that we were a manufacturing company, differing in no essential from any other manufacturing company. That our business was the production of light which we sold as a light. Therefore, we wanted to know the cost of that production on the same principle that a manufacturer who made a yard of cloth and sold it on the market at a given price, wanted to know what it cost him as a whole. Further than that, in order to conduct his business properly, he wanted to know in what that cost consisted. It therefore remained for me to divide that cost up. In doing that I bore in mind that there was a fault or defect, in too much detail. That any concern should at least have one head who should be able at all times to appreciate and understand the condition of its business; one in whom they should confide to the uttermost. Otherwise I should have spread this thing out in greater detail. In our own case, as it existed then, we had three classes of products, all of them alike. The first were day lights running from 7:30 in the morning until 6, and some of them up to 10 at night. Next, evening lights, starting at three or four o'clock in the afternoon and running until 12. Next, all-night lights, starting at 6 in the evening and running until say 6 o'clock in the morning. Each one of those three classes lapped into the other. It was utterly impossible, so far as I could see, to find just exactly what was the relative cost of those three classes of products. Not seeing a way clear to do that, I knew of no better way than to strike a general average. As you have this memorandum, I will refer to it by numbers. As an auxiliary to this, although it does not enter into the subject which I propose to confine myself to, is our regular record. I think we have a pretty good way of doing it; I do not know as there is a better way. Our business is divided up into the three classes of business. These reports come in to me at the office, and the report shows that we rent a certain number of lights from seven in the morning until six in the afternoon, aggregating a number of hours so much. The same with the evening and the same with the all-night lights. This report is made out at the end of every month. In order to make that, we take the aggregate number of lights and the aggregate number of hours. We put in our first line the number of lights. We carry into the second column, over to the left, what we had charged for these lights, what our light account stands charged with for that month. We have there other sources that are hardly worth mentioning; but it is to cover a little motor service which we have, not as a power service, as it only amounts to four or five hundred dollars a month. We convert that into what is equivalent to lamp service by taking the average returns of our lamp per month which would be fifteen or ten or twelve, whatever it is, and divide it up into that amount, and call it so many lamps. These motors are all run in the service rendered by the day service, or its equivalent. Then we deduct from that amount which we have charged against the lamp account, all rebate, all discounts, and all claims of whatever character that have been presented to us during that month, and which have been accepted; and deduct from that amount, and carry into our outside column the remainder, which gives us our charge against the light account. Now, we have in our method the charge for lights and schedule of prices. It is based on the service rendered: for day service we charge so much; for evening service we charge so much, and for all-night service at so much per light. But that rate is again charged each kind of contract the party gives us. The best contract we can get, in our estimation, is a contract that runs for twelve months, and in which contract we make the lowest price, as the short contracts are almost invariably made to cover the winter months of the year, which are the most valuable. For instance, if we have a contract for six months, from Oct. 1 to April 1, we have put out of our possession a lamp and get only a certain revenue for six months. At the end of six months that lamp is thrown back on our hands again and we are deprived of any additional revenue. Consequently all that we can calculate against that lamp is the service that lamp renders us for that 12 months, which is our fiscal year.

Now, for that class of service we charge a higher price. In order to get the average we take that total amount charged against lights, take the total number of lights charged during the month and divide it into that number, and it gives us our average cost and average price received for lights during that month.

So much for the starting point, which is our revenue account. Of course, to get at that we have to deduct our expenses. Our method of arriving at the cost of these lights is precisely the method of arriving at our revenue. It is an average cost. By dividing our total expenses by the total number of lights, which we have divided into our total income, we get the average revenue from the lamps. That, certainly, as a whole, I think, is an undisputed way of arriving at the cost of that product, and the average revenue received from it.

In regard to arriving at the average price received, that is arbitrary. There can be very little chance of making a mistake in that; but in the other there is great room for mistakes or discrepancies.

Now, having arrived at that cost of production, no man can prosecute his business and take care of it without being familiar with the various items of which that cost is made up. I have seen fit to divide that under: First, pay roll; second, general expenses; third, taxes; fourth, interest; fifth, extraordinary; sixth, coal; seventh, carbons; eighth, engines (I mean by that, repairs and maintenance); ninth, dynamo; tenth, lamps; eleventh, lines. Now, these are our general heads of items under which we group our costs. This statement is made up for my own particular use, and for any other who sees fit to use it; but as they go into a detail which the average officer of a company has not the time or disposition to take up, they are not material to this statement, but for explanation here I will say we divide the pay rolls into three classes. First, the electrical department, which pertains to all matters under the electrical head, or general superintendence. Second, the motive power department, which pertains to all matters in charge of our chief engineer. Third, office pay roll, which has been in my own particular department. The general expense we group into stationery, cartage, expressage, freights, horses, tools and miscellaneous items. This generalizing can be extended almost indefinitely. Taxes, we cover into that, state, municipal, water rents, insurance, our license charges, and I believe that is all. They appear on our books not under separate heads, but as separate charges, with the understanding that they go into the general books of account. The interest account covers many fixed charges of interest either as against us or credits where we have made discounts. The extraordinary account means simply this: It is the experience of every corporation—certainly my experience for a number of years—that we have never yet had a year in which we have not been subject to some expense, some charge, which we could not foresee at the commencement of the year, such as legal expenses, damages, and such things as that.

Now, I will stop there, as our expenses are divided there, and call them all the general expenses. In regard to these three items, I will have to go back a little to explain that to you. When we get to the end of this month, which we always take on the first day of the month, and our books are ruled in sheets for that purpose—on the first day of the month you can go and get the result. I am prepared to say that I will give any of our board a check or cash for that return at any time. They can have it. They can keep it. I do not want it. That is what I mean by the absolute net revenue of the corporation.

That you may make comparisons from one year to another without trouble, you have got, in some way, to eliminate these three unknown factors, taxes, interest, and extraordinary expenses. In the city of Philadelphia the bulk of our taxes, in order to get the benefits of what discount can be had by prompt payment, should be paid, or at least three-fourths of them should he paid, in the first three months of the year, and it is a very considerable item. I think that our taxes in Philadelphia, coming under that head, amount to about fifteen thousand dollars in the course of a year, and the result would be, if you had thus charged off at the time they were paid, that you would have a variable result from month to month on your returns. The same way with the interest account, and the extraordinary account; therefore, at the commencement of the year I think this is a wise and convenient way of handling these three subjects. I refer to the year previous; I see what they are. If the tax account has been so much, I divide it by twelve, as there are twelve months in a year. That one-twelfth I charge off every month, having an account on the ledger with these three items, and debit and credit these accounts. Experience enables me to see how I am coming out at the end of the year. I seldom get more than $300 or $400 out of the way, one way or the other. That method of charging the proportionate amount off every month enables you to keep the correct run of your business. The total account we divide the same way by the number of lights and the same way with carbon.

Engines I have subdivided again into machinery oil, cylinder oil, waste, belts, shafting and miscellaneous expenses. We have to draw the line somewhere on the charges on this expense, and therefore we make a rule where this line shall be drawn that is known to everybody whose business it is to make these charges. For instance, on the engine, all belts such as counter belts, main belts on the engine and anything up the belt that goes to the dynamo is charged against the engine account. The shafting expense; all repairs to that is charged to the engine, and the pulley and everything of that kind, boilers and all repairs to furnaces, the repairs to tools, piping and the pumps, and all other items which are innumerable and classed under the head of miscellaneous. The dynamo expenses are subdivided into oil, waste, belts, brushes, armatures, commutators, segments and miscellaneous items. Lamp expenses are divided into spools, cut-outs, armatures, carbon holders, carbon rods, insulation globes, miscellaneous and incandescent expenses. The incandescent expenses are put in there because our expenses on that are so small that they do not

amount to anything. The line expense we divide into poles, wire and miscellaneous items.

Our books are so ruled that they correspond to every one of these items. The storekeeper has charge of all these supplies, which he has got by reason of making the proper request for them to the purchasing officer. When this account is summed up at the end of the month we take each of these departments, having found what the total expense is. There is no getting away from that. We have to pay that amount. Now, it is to be divided among those different things. The result of it is that I think any one who would go over these statements for the last two years, particularly, would be struck with the uniformity of the expenses under these different heads. If any one month shows a marked increase of expenses on any particular item, it is very short work to put your finger right on it. I do not think it is worth while for me to go into the starting points of these. Mr. Smith gave you that very clearly. His idea as expressed in his paper, of handling that part and getting his stock out into the proper channel is very good and does not differ very materially from our own way of doing it; but when we get this through we have got in that statement every manner and form of expense that it is possible for us to incur, and certainly all the money that we have spent. You may have an expense item against your engines this month of five times what it was last month and five times what the average has been. It may be caused, as it was in one of our statements recently, by having to rip out the cylinder. There was an expense of three or four hundred dollars in that particular item, more than it had been for the year previous; but that immediately goes into the expense account; it is not a continued expense; it is not as Mr. Field termed it, a variable expense. It is an extraordinary expense in one particular item and such expenses are bound to come sooner or later. Following that through and to go into the detail which is the value of this paper in my judgment, nothing can go without constant watching; but if I see that the cost of our lights is running along uniformly from month to month my interest in that statement is a general one. If I find that the increase in cost for one month has been 10 per cent. or 15 per cent., I want to know why. I immediately go to these points and see. If it is a legitimate increase I cannot help it, but I do know that it has gone into the expense account and that is the end of it. If it shows a decrease I am interested in that, because if it is a legitimate decrease in the cost of that product I want to see if it can be maintained. If it is a decrease in some little peculiarity in that month's business, of course I regret it is such. If you would follow that out, and subdivide the expenses, and have your two columns of average cost and average revenue, and compare them from month to month, I know no better way of keeping track of your business nor any better way of educating yourself up to the true state of your own affairs than that. Of course these results are governed somewhat by the amount of service you are rendering. If you find from the statement this month fifty thousand total lamp-hours cost so much, and our average run on those lights is twelve hours, and next month our average run for the same number of lights is ten hours, and our cost is reduced correspondingly, then we have made no particular progress. The expense has got the benefit of a shorter run. The purpose of this sheet is the use that I make of it in turning it in to a board of directors who know what they want; and what they want is the net result of your statement. But for the guidance of others who are responsible for running the station, you have got to go into further details. You take the whole number of hours burned as an aggregate—in some of our statements it is 600,000; that will enable you, with very little work, to find out what it costs you per hour to run your lights. I do not think it signifies anything at all, so far as enabling you to fix the price of selling your product, but it does enable the engineer to say, "Last month our coal cost us half a cent an hour, or, for ten hours, five cents;" and next month he comes and says, it cost four and a half. That is all right, but if it has been because of the relative difference in the nature of the service he has rendered it does not amount to anything, but it is a point which aids the party who is to do this work to carry it out. I am not going to say anything more on this, but I do want the thing criticised. I had rather have the time taken up by criticism than anything I have to say.

There is another point about this, all our supplies are drawn out of what we call the merchandise account. Of course we sell some little things and sell them at a profit when we can, but when charging these things out for our own use the instructions are to charge them at cost in one sense, but a perfect cost, to give the company the benefit of a little margin to cover waste and things of that kind. For instance, it is our custom, if wire costs 16¼ cents to charge it to our own account at 17 cents, making nominally a profit of one-quarter of a cent on that wire. We fix the value on our merchandise stock at such an amount only as is necessary to keep us supplied in our business. For instance, we say $5,000 of stock is enough for this purpose. We have a merchandise account on our ledger. It stands at $5,000. If we charge everything out to it at cost and put everything into it at cost the difference between our sales and what we put in should represent the difference between our two balances at the end of each month. I cannot always do it, but if a rule of that kind is followed, and I come in this month and look at our merchandise balance, I go to the storekeeper and say, "You seem to have a thousand dollars more stock than you had last month. What has been bought?" If it cannot be accounted for without much trouble I want an account of that stock taken. If it is the other way, and shows the decrease of a thousand dollars, or some amount which I think is out of the usual order of things, I want to know in what particular it has been reduced. If it cannot be pointed out, an account of stock ought to be taken. We take an account of stock every six months. The custom of charging a slight margin on the stock against ourselves has resulted and always should result in a credit balance at the end of the year or six months when we take stock. In the eight or nine years that I have been running business in that way, there has always been a margin over and above what I have reported from month to month on this paper. Another thing, if you keep your stock down to the minimum and they throw the whole thing overboard, they cannot hurt you very much. My policy is to keep a low stock, just large enough not to interfere with the means of running the business. That method of keeping your books gives you a certain basis for the cost of your lights. It gives you certain returns which you can rely upon as accurate, and it is very easily kept, and if Mr. Field is here I want to say again that I see no harm in that method of keeping your accounts for variable expenses. The expenses vary from month to month undoubtedly, but nothing that should enter into a general report.

Another matter that I asked for time on this morning, but have not made much headway on, is this: It is a mistake that your income from increase in business so far outstrips increase in the cost of production. I am giving this from memory, as I did not think the matter would come up, and have not my notes, but I am not a great ways out of the way. I say, take a respectable sized station, 600 lights increased to 800, which is an increase of 33 per cent.; it results in an increase in cost of 10 per cent. An increase of 25 per cent., that is, from 800 to 1,000, results in an increase of 8 per cent. in cost. An increase again of 20 per cent. results in an increased cost of 7 per cent. Now, that is pretty nearly correct. We have thought of it; I know there was a time in our history when we started with 320 lights, I think, and we had so much expense. It was thought when we doubled it we would have a very slight increased expense. Well, we did double it, and we did not double the expenses, but it did treble the expenses we expected to have; and that has kept right along, and I do not know how to check it.

Mr. J. M. FRANCISCO: I consider this matter of central station accounts as one of the most important subjects that a central station man has to deal with. During the past year I traveled over quite a section of country, extending from Boston to Washington Territory in the northwest, as far south as this city, taking in nearly all the stations, numbering several hundred. In the course of interviews with the station men at different places I looked up this matter of accounts. I found that a large number, in fact the greater portion of the ordinary stations, what we call the smaller stations, kept no account whatever. They would start their plants, their engines, and lights; and at the end of a year they struck a balance. In a great many cases they found the balance was on the wrong side, but they could not tell where it went to, or anything about it. Now, of course, in running an electric light plant, these things must be considered. I have almost identically the plan presented by Mr. DeCamp, although I never saw his, nor never knew anything about his plan until now. But for two years I have worked on this plan. I have it arranged for the incandescent light; I have also an incandescent system, and have inserted columns that show that. At the end of the month the figures can be inserted, and that is all you have to do. Now, of course, if I am running an electric light plant, and I find that Mr. De Camp is running his plant for a certain cost per lght, while mine costs me one-third more, there must be some reason for it. In keeping an account like this, you can trace out where the leak is and solve it. For illustration, I take an account of coal. Every pound of coal that goes into my furnace every night is weighed. What we burn from the time we start to 12 o'clock is weighed, and what we burn from 12 o'olock until morning the same, and we get the average per hour. Now, a while ago I was away from home, and when I came back and the reports were handed in to me, I found that the coal accounts were far above what they ought to be. I called upon the engineer for an explanation of it. He said: "I do not know what the reason is; we have been running just the same way. I went to work after I had investigated the thing awhile, and telephoned for the coal man, and asked him if he would not call at the office, and when he came up I showed him the result. I said: "There is so much money that you want to give us credit for on our coal account." He could not, of course, see it as I did, but nevertheless he gave us credit, and there we saved several hundred dollars. It is just as Mr. Smith stated this morning. There is one benefit to a central station man in keeping an account. I know in running these small stations the men cannot keep an account like they do at the large one, because there are many stations where a man has to perform all the duties from president down to errand boy. Of course, he can simplify the matter to a great extent. In keeping his account he can collect the different items and get some idea of what it costs. If the central station men will adopt this plan throughout the United States, all those who belong to this association, it will be of great assistance. I do not believe that a central station man belonging to this association, but what if I should go to him and say, "Here"—of course there are some of us who might not want to divulge our secrets—but I say, if I found one man whose lights are costing him a certain amount of money, while mine are costing a good deal more, there is not a central station man in this association but what would sit down and give me an explanation of why it cost him less, and give me the benefit of his experience. In this way, if there is a leak in my business, I can stop it. This seems to me one of the great benefits of this association. I believe that every central station man above all things ought to keep these accounts. That has been my hobby for a great many years— "accounts." I have seen the benefits to be derived from keeping accounts many times, and especially in this business, because there are so many places where, if you do not keep track of your expenses in those things, it is going to eat you up. Of course, in running a business, it does not take but a little while to eat up dividends, if there is a waste. The moment your disbursements exceed your receipts you get a howl from the stockholders, and the question for us to consider is how we are going to prevent it if we do not know exactly what we are doing.

Mr. C. J. FIELD: There is something I want to try and make a little clear. The stations which I have taken my basis from have been incandescent stations, while the stations Mr. DeCamp has referred to are arc light stations. That will explain much of the apparent difference in the result which I have mentioned, and which Mr. DeCamp has given. Another thing, he don't say where, on his list here, he gets his fixed expenses and variable expenses. I will say that the stations I have been familiar with that kept such an account as this are incandescent instead of arc stations, but the principle is largely similar to the basis on which I figure the fixed expenses and variable expenses. They are from different stations, and are the actual results for different years, with different lights. I did not put in, in variable expenses, any expense of a break-down, or for armatures and dynamos, or anything else: that is all in your general operating expenses. My variable expenses were those expenses which you get by taking a station account, for instance, last year, when it had 10,000 lights on, and taking it again the 1st of January, when it had 20,000 lights on, seeing that you had a fair comparison, and seeing that there was included all those other charges which it is practicable to observe, and charging up an average over the twelve months. I know we have done it in our station, and have made an average. The month I have taken is a fair representative month, and shows a comparison on which we can rely without any danger of incorrectness. It shows us the practical information which we want. That is the information which we want to lay before the board of directors.

Mr. DECAMP: I think at the last convention at Niagara there was a committee appointed—Mr. Foote, if I remember right, of Cincinnati, who was going to prepare, for the benefit of the Association, a simple set of operating accounts and expenses. I do not know what has been done with that; but it seems to me that the Edison Association has done that and have found it a great benefit. They publish it for their own people. It seems to me it is going to be of much use to the members of this Association; it is going to bring this Association to that basis where it can be supported more and more, and give the true benefit to its members for which it was established. If anything has not been done in the matter of these accounts, why, I think it should be taken up and pushed.

Mr. H. W. LEONARD, of New York: If I understood Mr. DeCamp correctly, I think the figures he gave illustrate themselves the point which he apparently has not seen. If I understood his figures correctly, he gave as an instance that a station running 600 lamps, increased to 800 lamps, increased its operating expenses about 10 per cent. Is that correct, Mr. DeCamp?

Mr. DE CAMP: The operating expenses decreased 10 per cent. per light.

Mr. LEONARD: A decrease per lamp?

Mr. DE CAMP: Yes, sir.

Mr. T. C. SMITH: I think if we want to get a comparison between central stations, there is one thing that must be eliminated, and that is the dollars and cents of the question. It is all very well for us to meet here to help one another if we can. But there is an inborn objection to letting anybody else know our business. If another central station man comes to me, and says: "How many cents or fractions of a cent does it cost you to produce one-sixteenth candle-power for an hour," it is very likely I will not tell him. But if he says to me, "Taking your fuel, your rent, your taxes, your affairs and so on—taking these different items as amounting to 100, how many of that 100 do you charge for fuel?" I am perfectly willing to give it to him, because that does not tell him what it is costing me. It is giving the percentage of cost, and I have no objection to doing that. Now, if central stations all over the country work in that way, the man in Albany finds his lamps are costing him 20 per cent. of the total operating expenses for fuel. Another man in some other town, who pays precisely the same price for coal, finds his fuel account is 30 or 40 instead of 20 per cent.; he realizes there is something wrong, and in this way can correct the evil. It may be in the one case that the man is using a compound condensing engine, and in the other a high-speed engine. In one case he may be using coal that cost him a dollar a ton, and in the other case coal that cost him four dollars a ton, and yet the man who is using a high-priced coal will get the best result. We use a coal which costs us a dollar a ton more than some others we could get, and count it the cheapest, because the item of hauling away the ashes with us is very heavy.

I have been asked several times how to handle the depreciation account. I do not know of any better way of doing that than by having no extraordinary account, but one repair account. The repairs cost so much, from year to year. The fact that we have a smash-up and repairs cost us a little more for one particular month, ought not to have any effect with the directors when it was explained that there was a breakdown. But if at the end of the year it would appear they were too much, they should be looked into. We should want to keep our account near the point which was settled upon as about the true basis. That is to say, every time there is put in a new engine, or a new dynamo, or a new boiler, it should be charged to construction account. But when you find that the engine is worn out and you want to change it, you charge the new engine to repairs and sell your old one for what it will bring. The only increase in your capital account are your legitimate construction expenses. It is the same in a pole line. If a new pole goes in where there was a pole before, that is charged to repairs. If it is a new pole in a new place, it is charged to construction.

President WEEKS: If you will pardon me, Mr. Smith, what do you do if there is a change in the market value of material?

Mr. SMITH: That you will have to charge to repairs the same way. You will get the benefit of the cost when you put in a new machine. The new machine is going to cost you less than the old one did; consequently you will not charge so much for depreciation.

President WEEKS: To illustrate that: We can all remember when a sewing machine cost from one hundred to a hundred and fifty dollars, while we can now buy them at from ten to thirty dollars. Will not the same be true, to a considerable extent, with regard to electrical apparatus? What will you do with that shrinkage?

MR. SMITH: If you bought a dynamo for which you paid $1,000, the first year it is worth $1,000. Every year your dynamo decreases in value; it gets worn out. When you get your new dynamo in, you get it for less money. Your capital account remains the same. You have either to make a gradual drop in the value of your plant in making your annual statement, or take an estimation of the value of the plant. I want to get rid of the depreciation account, by making it all repairs. If you can buy your machine for that much less money, I think it simply means that your repairs have been less for that year, come down every year, and your plant is worth more in its capitalization than a plant which costs a greater amount. I think one will be fully offset by the other.

Mr. DECAMP: On that point that Mr. Smith just spoke about. A rule, which I think is a good one in this depreciation account, is this: The depreciation account is an unknown quantity; it is a conservative way of guessing at things or keeping account. A rule like this will always enable you to be on the safe side. Merely incidental repairs are not things that affect it one way or the other. But when it comes to the general repairs, and you work on this principle, if after those repairs are made, if your engine or your dynamo or your boiler is as good as new, then your construction account is not affected. Overlook all charges or all depreciations, if not connected with any general expenditure of money.

Mr. SMITH: I would explain in speaking of the capital account—I did not make it quite clear. Of course, the

capital account is always a liability, I mean in estimating your assets. It would be a simple way to keep those assets from year to year to put them at the value you think they could be replaced for to-day.

Mr. F. A. WYMAN, of Boston: My experience has been that this so-called construction account should be called a "destruction" account. This running of expenses into the construction account destroys or ruins more people than any other item in the business. It does not seem to me right to build a new station, run it ten years, let it pay 10 per cent. per annum, and at the end of ten years have to build it completely over again, so that your plant is only worth 50 cents on the dollar. It seems to me it is better to start out and pay a five per cent. dividend, and charge the other five per cent. to depreciation. Of course, it takes courage to charge this up. A party making lights very cheap, and having exclusive control of a city where they are getting a high price, tries to make his operating expenses as large as they possibly can be made, but in a small town where there is only a small dynamo capacity, they try to make their construction account as large as can be. You have to steer between the two. I want to give you a practical illustration. About twenty years ago there was a gas plant started in a good-sized town in the East with one hundred thousand dollars capital. The other day in looking it up we found they had a paid-in capital of thirty-five thousand dollars. They had thirty-five thousand dollars worth of property left. The other $65,000 had been paid away in dvidends. They had not kept any depreciation account; it all went into the construction account. I wanted to ask Mr. DeCamp in regard to the taxes. I understood him to say $15,000 a year. Now, I would like to ask if he buys water by meter?

Mr. DECAMP: Yes, sir.

Mr. WYMAN: Why should that not be charged every month as you charge your coal?

Mr. DECAMP:—There is no reason why it should not be done. It is a matter of detail. In our case we get our water every month, and in this appropriation that we make for that particular account we include that. I think I can come within $50 a year of it without being obliged to go and take the register of the meter, as we have no check from that department, which only takes the register every three months.

Mr. WYMAN: Does it cost you more to run a light in the winter or in the summer?

Mr. DECAMP: It costs us more in winter, because the hours are longer. Our average run in winter is longer.

Mr. WYMAN: I mean hour by hour. Does it cost you more to run in the month of July than in December, or vice versa?

Mr. DECAMP: I do not think I could answer that question. I do not think it does, but mainly for these reasons: The month of July is our short month; that is, we are running at the smallest number of lights. During the month of December we are running everything we have got, and we have the benefit of having everything utilized; and, consequently, taking the month of December for the last six years and comparing it with July, I would rather be inclined to think that the average cost was less per light for the month of December than for July, but mainly for that reason.

Mr. WYMAN: On account of the use of all your plant?

Mr. DECAMP: On account of having that plant fully occupied and running at its best capacity.

Mr. WYMAN: Do you keep a separate account between your outside and inside wiring?

Mr. DECAMP? You understand I am talking about arc lighting. What do you mean by "inside wiring?"

Mr. WYMAN: I mean where you have to put wires inside and outside both. Do you keep separate accounts of them?

Mr. DECAMP: Yes, sir. We get an order to put in three or four lamps in a building. We cut it in off a line already established there, and it costs us simply for making that particular installation.

Mr. WYMAN: Do you think that the inside wiring should go into current expense or construction account?

Mr. DECAMP: We put the wiring that goes in there into our construction account. That is a matter which I sit in judgment upon. It is according to what it is; but our rule is to charge everything that goes in there. Anything that is likely to be lost and all the labor, is charged to expense. Now, I do not think that is far out of the way. Before I established that rule, I went over a large number of cases and found where I had taken out a wire and fixed the thing up at that particular point, that the losses on that account seldom exceeded five per cent. There is no danger if it is properly looked after, and in regard to what I say it takes somewhat more than an ordinary clerk's interest in the matter to pass judgment upon it. In some cases I have struck it off entirely and charged it to expense account, because I thought the likelihood of getting anything out of it was very small. Of course that which is returned is second-hand, and if we get that second-hand material back it does not go into our stock as new stock. Some of it goes right into the scrap heap. Our storekeeper has the discretion to put it in there at what he thinks is a fair valuation.

Mr. BURLEIGH: I think there should be no such account as a depreciation account. In arriving at that calculation I was interested in watching the plan of the Pennsylvania Railroad Company, who have given a great deal of attention to accounts and the best plan of arriving at values, and they do not have any depreciation account. They aim to keep their road and its equipment up to the standard all the time, and charge it to expense. Anything new that aids their railroad is charged to capital, and that which replaces what is worn out is charged to expenses. There is no such thing in their accounts as a depreciation account.

The CHAIR: What do they do in case of change in market value? Do they make any allowance for that?

Mr. BURLEIGH: No, sir; they do not. Take the case of a locomotive which is valued as scrap at perhaps $1,000. That is replaced with a new engine costing $8,000. The $8,000 is charged to expenses. They aim to keep their railroad and its equipments all the time up to the capital value.

Mr. WYMAN: I would like to ask Mr. Burleigh if the Pennsylvania Railroad Company has established the value of their road on the earning capacity of the road? Is that the standard they use? With us, we do not know what the earning capacity is going to be this year and next year. If the Pennsylvania Railroad, Company, for instance, declares a four per cent. dividend then their stock would sell at 125; if six per cent. they would be selling at 175. They do not take account of stock as we do in the electric light business. They say, "We have got an earning capacity of so much, and the value we had 30 or 40 years ago has nothing to do with it at all. We will earn that next year, consequently our construction account is all right." I do not see how we can compare with them.

Mr. BURLEIGH: They know exactly what they have got, and so can we know. They want to know whether they have a railroad worth what they have it capitalized for. We want to know the same thing. They have to take an account of stock, just as we do. They know just what the value of their railroad is, and it is not the earning capacity in that sense. We are so particular in our company in Camden that we have everything in that direction go to expense. If we find by an account of stock that the values of what we have on hand are not what we are capitalized for, the board takes action and charges it to expense, aiming to keep it up all the time to what it is capitalized for.

MR. LOCKWOOD: I am interested in this subject because about a year ago I asked Mr. De Camp, of Philadelphia, and one or two other members of our association, for information regarding how they kept their accounts, and in what manner they found just what they were doing, and knew what to count upon as the result of the electric light business. I believe, from what I have heard of Mr. De Camp's method, and what I have read about it to-day, that the plan of going down to the basis per month is the best. The nearer we can get to that, and the more accurately, the better basis we are getting to work upon.

Now, the point of expense: I believe the nearer we can bring the expense down to the basis per month to compare it, so that we know each month what we do, and not have to wait until the first of January, or whatever date we take our inventory—I believe the nearer we do that, the better we will be informed and the better we can carry out the improvements suggested by the results. I had this case in a company with which I was connected: We found just what the major part of our accounts was per month, such as coal and labor and accounts of that character, and we charged this into the total running expenses for that month. Then we found that the interest and taxes and accounts of that description, repairs included, varied very greatly. The interest and taxes, it is true, we had to pay only once a year, but the repairs we studied over and arrived at this solution: We created what you might call a balancing sheet, and we estimated at the beginning of the year how much we would likely have to charge up during the year for taxes, insurance and accounts of that description, and then we started in and charged up each month in our monthly sheet what we thought was the proportion that that month would have to the total year. If we did not pay our taxes till the ninth month in the year, there was accumulating upon this balancing sheet during those nine months of certain amounts, and we credited the same amounts in the monthly sheet as in the balancing sheet, and then taking the proportionate amount of that nine months, we charged up the proper proportion in the remaining month. We adopted the same system for repairs. Instead of charging up each month just what the repairs were, we estimated as near as possible what they would amount to in each year, and then charged up one-twelfth of the amount we had estimated for the year, and as the end of the year drew near we could see what the credit or debit on our balancing sheet was going to throw us out of our estimate, and if it was we divided it among the remaining months, and then it up proportionately to each month in the year. I believe that in this way we will better know how to make improvements from our investigations.

One point spoken of is how to charge up inside wiring. We did it this way, and we may be right or wrong: We determined to charge consumers for their inside wiring, at a fixed price, unless the amount of wiring was very largely out of the usual course. We put it up for $5 a lamp, and though it may cost us $10, we charge that up, and if there is a loss, it goes to profit and loss, and if there is a profit we make the proper entry of it. Then it can be carried as a merchandise account, and I think that is a very fair way of doing it. As to repairs, I think the right way is to keep your station in every respect up to the highest standard. If you simply make up for what is depreciated by wear and tear, I believe every cent of that should go into the running expenses and be divided up on the system of the balancing sheet and distribute it through the different months of the year.

There being no further discussion of the above topic, the paper and discussion upon it were ordered spread upon the minutes of the association.

Mr. PHELPS, of New York, read the following telegram:

"NEW YORK, Feb. 13, 1890.

To Mr. George M. Phelps, Coates House: Just returned from Richmond, where bill for restriction of voltage in Virginia has been reported adversely by unanimous vote of Senate Committee after two days' argument. It was supported by Edison in person, and the electrical executioner, opposed by Westinghouse representatives aided most efficiently by local companies at Norfolk, Alexandria, Petersburg, Lynchburg, Fredericksburg, Richmond, Liberty and others. (Signed) R. W. POPE."

The reading of the telegram elicited a hearty outburst of applause.

Mr. M. D. Law, of Philadelphia, then read the following paper on

NINE YEARS WITH THE ARC LAMP.

In being honored with an invitation to read a second paper before the National Electric Light Association, I could not help but feel that there were points of interest to some of you in my other paper presented at the Niagara Falls Convention. The subject of this paper is one that is of interest not only to every central station man, but also to those who handle arc lights in isolated plants; and if I can give you but one point that is of value, I shall feel amply repaid for my labor. There are a large number of irregularities in arc lamps that can be remedied by a judicious study of their actions, and, after the cause of their trouble has been found, it should be remedied even if the lamp has to be rebuilt.

In order to find the special trouble that arc lamps are subject to, a careful record should be kept of each and every lamp. To do this, give each lamp its individual number, which should be firmly attached to the lamp box and never removed; then by the use of a numbered book, allowing a page for each lamp, a record may be kept of all lamps, where they are, when changed, with the kind and amount of repairs.

This method of keeping a lamp record allows of finding the peculiar trouble that the lamp is subject to, and the remedy can then be applied, preventing any further trouble until the washers, clutches, rods or bushings have to be removed. If a lamp is continually being changed for the same cause, there is some one thing that is radically wrong, which is causing the trouble; this should be rectified. For instance, a lamp may work perfectly on the test rack, but, after being in use for a short time, would have to be changed for dropping. If from the records of that lamp this is found to be its general complaint, then look for the trouble, if a Brush lamp, in the winding—that is, there may not be the proper resistance of wire on the magnets, or there is too great a difference in resistance between them, which should not be more than one ohm; or the result of a side puller. The resistance of the shunt magnets should be kept as near as possible to 85 ohms; never allow more than three ohms variation from that amount.

Binding of the mechanism, large washers, or too high adjustment of the arc will cause dropping; in hunting for the cause of this trouble in the Brush lamp I found that, with proper construction, it could be made to work without dash pot or spring, better than the old style with dash pot and spring.

I assume that in a differential magnet there must be a point of equilibrium between the two magnetisms, and that if the cores were accurately suspended at the centre of this point, that any variation of current would affect the core quicker if so suspended than if it was forced to or from that point by a spring; this I have found to be the fact. Then by making the lamps so that the core could be adjusted to or from the centre of magnetism and getting the proper separation of the carbons at that point, would effectually prevent dropping of the carbon rods; and after a Brush lamp is once adjusted in this manner it will not get out of adjustment until the washers are worn too large. This can be done without glycerine being used on the rods, which is a great source of trouble.

Another point wherein expense is saved in the Brush lamp is in the winding of the cut-out magnet. Divide the magnet in two parts by an extra fibre head, and then by winding the fine wire at the top, with a resistance of fifteen ohms, the coarse wire can then be wound on at the bottom, allowing the end to make connection with the cut-out armature at least one-half an inch from the head of the magnet; this will reduce the chances of burning out, if there is a bad contact when the lamp cuts out; even if it does burn out, only one wire will have to be removed.

If the following rules are strictly adhered to in the putting together of a Brush lamp, it will be found to burn correctly with but little adjusting:

See that the device carrying the lower carbon holder is parallel with the side rods; also that the screws, etc., at its base work freely and allow it sufficient lateral motion in all directions to affect the adjustment for which this device is provided.

See that the lower carbon holder is in line with its support, or the carbons will not centre.

See that the brass tube carrying the upper carbon holder is straight, smooth, and free from small or flat places, and that it moves freely in its bushings, which should not be too loose, as this will allow the carbon too much lateral motion, and makes it liable to slip past or wedge.

See that the upper carbon holder is in line with the rod.

This last adjustment is very important, and is made by clamping a steel rod of the same size as the carbons to be used in the holder and revolving it between the thumb and the finger, noting whether the lower end of the testing rod revolves on its own axis or "wabbles;" in the latter case, push the holder up to the lamp box, and, by means of the testing rod, bend it slightly in the proper direction to correct the error; then see that the carbon holder has not become loosened; test again, repeating the process until the desired adjustment is reached.

Examine the lifting washers which surround the carbon rod; see that the hole is counter sunk on each side, so as to make the available thickness of the washer where it touches the rod but little more than a sixteenth of an inch. See that the hole in the washer is of such a size that one side of the washer may be raised one-sixteenth of an inch from the horizontal floor on which it rests, before it clamps and commences to lift the rod. See that the holes in the washer and bushings are nicely polished. The lifting finger, designed to lift the washer, should move freely in its guide and get a good hold under the edge of the washer, and allow the latter to rest flat on the floor under it when the finger is down. In the case of double lamps, the lifting finger should be so adjusted as to lift the second rod one-sixteenth of an inch ahead of the first.

See that the movable brass parts connecting the lifting finger with the movable magnet cores work freely at their joints, so that no binding of the parts may be possible.

The spring which partly supports the magnet cores should be made of steel "pianoforte wire," twenty-seven thousandths of an inch in diameter, wound closely over a mandril of such size that the spring, when released, shall have an external diameter of seven-sixteenths of an inch, and shall consist of about 28 turns of wire exclusive of the hooks at the ends.

See that all the parts of the dash pot are free and do not bind. See that the armature of the cut-out moves freely on its pivot; and when it is down its end is about one-quarter of an inch from the core of the cut-out magnet, and when it is raised and makes contact with the copper wire projecting from the cut-out magnet, that its end comes about three thirty-seconds of an inch from the cut-out magnet core.

The brass spiral leading from the cut-out armature is not used as a spring, but as a resistance. It must be pulled out or pushed together as the case may require, that it shall exert neither a lifting nor depressing influence on the armature.

This spiral is made of brass wire twenty-nine thousandths of an inch in diameter and about thirty inches long before being coiled. The size of this wire is important as it should be of just the right resistance, that the lamps may cut in when the carbons come together; for this same reason the armature is not allowed to come close to the core of the magnet, but should be made to come as close as possible, that a better contact may be made, thus reducing the liability of burning out.

The principal improvements that can be made in the Thomson-Houston lamp are, the making of the clutch of German silver or some more durable metal than brass, as the wearing point of the clutch against the rod is so small that it very soon wears and thus throws the lamp out of adjustment. When one of these lamps is found dropping, it can very often be remedied by lowering the adjusting nut No. 692 a trifle, when the lamp will again burn correctly, and, in some cases, this may be repeated several times without any other change in the lamp.

Another great point of improvement in this lamp is, increasing the thickness of the insulations, which are too small in nearly every case; especially is this the case with those under the binding hooks at the top of the lamp box, which I find work excellently well made of porcelain. When the insulator in part No. 701 gives out, the current shunts through the cut-out magnet, causing what the men term "cut-out armature magnetized"—this is a very important point which produces flaming and dropping.

The general causes of the T.-H. lamps dropping are numerous, but if all the working points move freely and without lost motion, it will reduce the number to the few following points: Badly worn spots in the carbon rods: this is a common fault in all arc lamps. The clutch or lifting spring may have lost their temper: these should be made of bright instead of black steel. Clutch arm bent. Clutch or carbon rod bushings may become worn. The adjustment nut No. 692 may be too high, the clutch or tension spring may be too tight. Crooked frames, bent rods, or rods strik-

ing the chimney, tight bushings, fine wire broken, dirty rods, or the adjustment nut No. 602 being too low, brush in the bushing may be too tight or become corroded or burned, and the magnetizing of the armature before spoken of will cause the lamp to flame and drop.

With the United States or Weston lamp the principal cause of trouble is the tripping from first to second set, and when this happens so that the second set burns first, it generally means a new set of contact springs and new magnets if the lamp burns entirely out of carbons; some of the causes for tripping are: Rod sticks or wants new contact brush, lever hook loose, rod scrapes chimney on first set or too much hook on first set, adjusting screw on long hook set too high, lost motion in rocker shaft.

Causes of long arc are, platinum collar dirty or worn out, trip lever sticking or too loose, carbons not burning in proper proportion, burning holder before the carbon rod is down far enough to make contact with trip, small hook dirty, rod crooked near the top, weak magnet, fine wire burnt, clutch holder or armature sticks, rod a little thick at the top and brush too tight.

Causes for dropping out are, weak magnet either fine or coarse, lost motion in rocker, stiff clutch, too much clutch, not enough clutch, slight nigger in coarse wire, plunger too stiff or too loose, plunger bent, broken or crooked plunger rod, bad carbons, which may on starting become soldered together and cannot lift.

The globe holder or the carbon holder of the arc lamp is a very much neglected part—that is, the insulations are not made heavy enough, so that the carbon dust or copper droppings falling over the insulations will give sufficient leak that a person standing on the ground and touching the bottom of the lamp may receive a very bad shock. This insulation should be made heavy and so placed that the carbon dust may not fall on it, as it is sometimes impossible to hang lamps under awnings high enough, but that when a person passes under them he may be touched by any conductor which he may have in his hands. No part of the lamp outside of the globes should be allowed to have current in it. Arc lamps should be suspended by some perfect insulator, the regular porcelain insulator and hook being the best in our experience; this is a very important point and is often negected, lamps being hung from an ordinary screw eye by a piece of wire are frequently seen, when it is as important that the lamp should be as well insulated as the balance of the circuit. Dirt must not be allowed to accumulate on any part of the lamp; rods, switches, bases and globes should be kept well cleaned, and all binding screws kept tight, the rods should be kept thoroughly well wiped every day with a clean cloth or waste, never allow crocus or emery to be used, as it badly wears the rods in the center; a better plan is if the rods become rough or dirty bring the lamp in and polish on the buffing-wheel, which will allow of its being kept of an even size its entire length. A properly tended lamp will need but little adjusting, but when it is required a regularly appointed man should attend to it, or the lamp returned to the station for repairs.

The longest record for any one lamp in a constant street service is three years and nine months without any adjustment other than the ordinary cleaning by the trimmer. In order to get a good lamp record, no lamp should leave the test rack until it is perfect in all parts.

The most vexatious part of the arc lamp is the globe; it swells the item of expense in spite of the utmost care, besides being a great source of complaint, for I never knew one to be well enough cleaned but there would be a complaint that it was not polished. The fused copper dropping and burning onto the glass makes them look dirty in spite of the best cleaning. I have found, after a careful experiment, that it pays to put wire nets (which should be made of copper) on all globes, even for street lighting; having them covered with wire nets prevents pieces from falling out even after they are badly cracked, and if the globe entirely gives way, the net will prevent its falling on some one's head. Undue heat after the carbon has burned close to the holder, is one of the greatest causes for broken globes. This can be partially overcome by leaving the globe about one and one-half inches from the carbon holder.

In looking over the reports of former meetings of this Convention, it is easy to see that nearly all of the discussions have been on how to save coal; of course this is a point where large money may be saved by use of proper boilers and settings, but the best of these will do no good without proper firing. There are many other points in the management of an electric light station which are just as important, the most serious of these is the pay roll, as two men more than is necessary will cost nearly as much as a ton of coal per day, and thirty tons of coal per month would be quite a saving. And yet while keeping the number of men as low as possible, none but first-class men should be employed, that all work may be done in a first-class, substantial manner. Especially must trimmers attend to their duty well, as the quality of their work dictates the amount of rebates to be allowed during the month. Another important man in this respect is the dynamo man. He should give the dynamos the most assiduous attention, that the strength of the current may be kept constant, while flashings and interruptions of the current may be reduced to a minimum, for no matter how well every other department of a station is carried on, if the current is allowed to vary from the standard, complaints will follow, and they are expensive.

There is nothing that angers a user of electric lights so much as to have them flash; it may be only one or two seconds that they are out, but it always seems like a much longer time, especially if in a crowded hall. Rather have the record for continuity of lights so good that even the gas fixtures may be removed; this can only be gained by close attention to the machines, wires and lamps. I call to mind one place that we have lighted continuously, without any other method of illumination than arc lamps; for over eight years, and during that time the lights have never been out during lighting hours.

The waste in the use of carbons is a very important feature. These should be dealt out and every stump returned; the amount saved in laying by the four and five-inch stumps to be used in the summer months will make a saving of at least ten thousand carbons per year for a one thousand light station. At the time I first started dealing out carbons and bringing in stumps, I saved on an average over thirty dollars per month, and then only trimming about four hundred lamps per day.

A very important feature of the arc light stations is the inside wiring and line construction which is very much neglected; all inside wiring should be of the best quality of insulation, and run on glass or porcelain throughout their whole length. An arc light wire should never be concealed. The use of soft rubber tubing for passing through floors, ceilings, walls, etc., should never be allowed, the only suitable material for such work is hard-rubber tubing.

While I am a great believer in the use of the best quality of insution for line construction, yet it is not the best to depend entirely on such insulation for safety. Put up the best wire there is, and then apply a rigid system of inspection and tests, not by that abomination of tests, the magneto bell. Not only should the tests be made on dead lines, but should be made at least once in two hours on all dead lines, and when grounds or bad leaks are discovered, they should be immediately cleared, by that means preventing the second ground, which is the element of danger.

I have repeatedly had lines that would test clear at the time of putting on circuits, but two hours after, solid grounds have been discovered, located, and found to be wires broken down, hanging over the electric light wires and reaching down to the sidewalk, where they are a source of danger to every passer by; besides every boy that passes must feel of it to see if there is any electricity in it. My orders are to drop all work that is not absolutely necessary to clear grounds. In Philadelphia we receive great help from the Electrical Bureau of the city, by their promptly reporting all wires discovered that are down on us.

All lines should be cut by one man, who is especially instructed and detailed for that work, as then you are enabled to pick out a thoroughly reliable man and drill him in the work that he is to do, then, by never allowing a circuit to be opened, and teaching all men to never depend on any insulation but to treat all wires and lamps as if they were charged with an electric light current, dangers to employés will be reduced to a minimum.

Supplementing the paper, Mr. Law said: In presenting this paper, I have done so with a view to benefiting, if possible, the central station men. You will find in the paper a few rules for the operation of the Brush, Thomson-Houston and Weston arc lamps, which lamps have come directly under my personal supervision. If these rules are strictly followed out in the repairing of those lamps, you will find but little trouble, and but little necessity of putting them on the testing rack. Another point that I would like to call your special attention to is the matter of testing arc-light lines. It is only within the last six or eight months that we have been putting a thorough test to line wires. Since the time of the Niagara convention we have perfected the system which I specified at that time, and I can positively now locate a ground at the station before leaving to hunt it up. Those tests are made at regular intervals of about two hours during the night and day on all live circuits. As soon as those circuits are discovered grounded my foreman is notified, and I also receive notice myself, and the proper men are detailed to remove those grounds as soon as possible, not allowing them to remain on. There are a number of points in the paper which I have not carried out to completion, but have simply called your attention to them.

In the absence of Mr. E. F. Peck, of Brooklyn, N. Y., his paper on "Carbon Tests" was read by Col. Ransom.

CARBON TESTS.

The first electric light of any consequence was used by Sir Humphrey Davy in 1810. He had discovered that when the two terminals of a charged electric circuit were separated a short distance, an electric spark would pass between these terminals by vaporizing the material of which the electrodes were composed, and that the vapor thus produced would contiuue to carry the current between the electrodes, and that these vapors together with the highly incandescent solid ends of the electrodes would emit a powerful light. The vaporized material bridging the space between the terminals of the electric circuit he denominated the electric arc for the reason that these vapors would pass in a curved-path between the two electrodes. Sir Humphrey Davy demonstrated this interesting phenomenon by using a great variety of material for the electrodes, and he found that the most brilliant effects were produced when the electrodes were made of carbons. The carbon used by him was charcoal made from various woods. It was found, however, that the charcoal, from whatever wood it was made, always had a considerable electrical resistance, and was so rapidly consumed that it could not be used for the production of arc lights for practical purposes, such as general illumination. Other electricians took hold of Sir Humphrey Davy's discovery, and their efforts were directed toward the discovery of materials for the production of electrodes of greater durability and better conductivity. It was finally discovered that carbon deposited in the neck of gas retorts possessed a high degree of conductivity and was exceedingly hard, and therefore would be very durable when used as electrodes for arc lights. Rods or pencils of this gas retort carbon were made and shaped at great expense and trouble, and they were found to be excellent substitutes for the charcoal electrodes; still these gas retort carbons could never be used on a large scale for the reason that, being exceedingly hard, they could be shaped to the required form only at a very great expense.

The next step in the improvement of carbon electrodes for arc lamps was made in 1842, when Bunsen invented what he called the "plastic" carbon as the negative electrode of his battery. This carbon electrode was made of various mixtures of powdered charcoal, molasses, sugar, etc. It could be shaped to any desired form, and was made by Bunsen in the shape of hollow cylinders and flat plates. When it was found that this carbon electrode could be used to advantage for the production of electric arc lights, it was at once substituted for the gas carbon. This substitution was not a univeral one, for as late as 1873 and 1874 Professor Tyndall was in the habit of using gas retort carbons in the production of electric arc lights, although he complained bitterly to his audiences that the production of his carbon electrodes involved great expense and trouble. The carbons burned at the Centennial Exposition in 1876 were of this material, but we have no data as to their life or resistance. They were made by Carré, of France, and the current was from a Gramme machine. From 1843, when Bunsen invented his "plastic" or molded carbon, to 1879, many inventors in this country and Europe tried to improve on his discovery. Their chief object was to produce a carbon of greater and more uniform density and of higher conductivity. The English patents were especially numerous during this period, and their contents in the more enlightened state of the art seem very ludicrous. Though some labored at the problem nearly fifteen years, on the whole no great improvement was made.

This poverty of result was largely due to the fact that the dynamo apparatus of the day was unknown. All arc lights were produced by currents generated by batteries. The modern arc lamp with its simple but effective mechanism was unknown. The arc light was only a curious laboratory plaything generated expensively, and burned disadvantageously. The proper experimental condition to enable an inventor to produce good carbons did not exist, and the financial stimulus of commercial demands was wholly absent.

The modern arc light carbon of commerce is hardly ten years old. It became a necessity as soon as the modern dynamo apparatus was completed and commercial lighting by electricity was seen to be coming in the near future. The real problem may be said to have been undertaken in 1878. The first point was to discover crude carbon that was both pure and cheap. At the suggestion of Mr. Fayette Brown, of Cleveland, O., his son, Mr. A. E. Brown, then experimenting for the Brush Electric Company, tried the residue from petroleum distillation. Careful experiment proved this to be the long-sought-for crude material, nor have the investigations of the past ten years found any better. The next point was to manufacture carbons of the requisite quality. Nearly three years later the Brush carbon was produced. The first cost of these was very high and the demand small. Where carbons are now sold by the hundred thousand they were then sold by the dozen. Like most new articles the process of manufacture was roundabout and tedious, consequently both the cost and market price of carbons ten years ago, was very high; the first carbons selling as high as $125 per 1,000. I cannot learn that any tests were made of these carbons for resistance, brilliancy, or even exact life. In those days manufacturers were well satisfied if they could make carbons that would burn fairly well, and gave other considerations very little thought, because they were relatively very unimportant. Besides Mr. Brush and his associates, there were several others in different parts of the country working at the carbon business on different lines. At Ansonia, Conn., the Messrs. Wallace & Sons, were experimenting with forced carbons, with much success, following the process of Carré, of France. This carbon was very dense and hard, and when sounded gave forth a ring almost like a bell. Not to mention many others, Mr. Thompson, of Newark, N. J., was also in the field; but, clinging to gas retort carbons for his crude material, he did not meet with the success achieved by his competitors. Since those early days of experimental work, manufacturers have paid special attention to reducing the cost, lowering the resistance, and increasing the brilliancy and life of the carbon.

Early in the spring of 1889, at the suggestion of a representative of one of the large carbon manufacturers, I decided to base a year's contract of carbons on the comparative test of the best known carbons in the market. I made two or three tests, taking into consideration simply the life and resistance of the carbons as adapted to the system of lighting we were using. The tests were rather crude and not made for the purpose of booming any particular carbon, but to satisfy myself as to what carbon I could best afford to burn. The final test was made with a group of Thomson-Houston lamps on a 6½ ampère circuit. Two sets of carbons of each make were placed in the lamps and each lamp adjusted to the lowest point at which a quiet arc could be maintained. A record was made of the time of starting each lamp, and they were then allowed to burn till the lamps had cut themselves out automatically by the burning out of the carbons. The electromotive force at the terminals of each lamp was then recorded at intervals of half an hour through the day. The result of the test, stated briefly, was as follows:

Lamps.	Nos. 1 & 2.	3 & 4.	5 & 6.	7 & 8.	9 & 10.	11 & 12
Average E. M. F.	42.23	42.73	47.16	48.37	47.76	49.68
Av'ge ins. burned per hour.	1.23	1.46	1.44	1.57	1.72	1.69

As will be seen by this table, there was a difference of 7.43 volts, or a saving of about 15 per cent., in the E. M. F. of the best over the poorest carbon tested, and a difference in life of .49 inch per hour or a saving of 29 per cent. In a station burning a thousand arc lamps this means a saving of 64.73 electrical horse power without considering the saving in carbons. The figures given above show very plainly the importance of such tests, and I would recommend that superintendents and managers of central lighting stations give this matter their consideration before adopting any special make of carbons.

President Weeks: Gentlemen, the subject is now before you for general discussion. I should be pleased to hear from any of the delegates on this matter. It is a matter of great importance.

Mr. Francisco: If it is not a secret of the business, I would like to ask Mr. Law with what instrument he tests grounds at the stations.

Mr. Law: I do not know that there is anything about our station that we call private. We are always glad to give any information we can. The manner in which I have been testing grounds at our station for the past year or eighteen months is by the use of a set of incandescent lamps in series; that is, I use 47 volt lamps for a 60 light machine; those lamps are put up out of the way, and a wire run from each one of those lamps to the switch plate. There is a lever to turn around in a circle making a short circuit of one, two, three, four, five, etc., to cut out one or all of those lamps. Now, if a wire drops down on an electric wire grounding it, the distance which that wire is away from the station is simply a measure of its potentials. Every two hours we test each one of our circuits, in the first place by testing across the circuit. The number of incandescent lamps then burning up to 48 volts indicates the number of lamps that are actually burning on the circuit, less the resistance of line, which I find amounts to about 10 miles of No. 4 wire for every arc lamp; then we test by placing one side of the incandescent circuit to ground, and the other side to line; then, by turning off my incandescent lights until I bring the voltage up to 47, I find a certain number of lamps burning. We will say 10 lamps on the positive side. Now I turn my attention to the negative side, and go through the same operation. If I find that I have 50 lamps on the negative side, I know that the ground is ten arc lamps away from the station on the positive side, and if your circuit books and diagram books are correctly kept, you can tell within two or three moments' time exactly the location of that lamp. In 99 times out of 100 we go to the right lamp.

Mr. J. E. Lockwood: I think this is a subject that desreves a great deal of attention, and that more would be done to prevent damage to electrical interests by false representations of the press by giving them no foundation for any report than by any other means that we have at our disposal. I will not take the time of the Convention now to speak on this subject, as I have a paper that I shall read to the Convention to-morrow morning. While I think the Law system is a very good one, I think we have now at command one which is much better.

President Weeks: Is there any further discussion of this subject? We would like very much to hear the central station men give freely of their experience. With the usual instructions to the secretary, there appearing to be no further discussion, we will pass this topic.

Mr. De Camp: I would like to ask a question. In Mr. Peck's paper he speaks of an arc lamp being burned at the Centennial in 1876. I will ask if any gentleman present saw that light? I was at the Centennial probably a hundred times and never saw it. I would like to find the fellow that did.

Secretary Garratt: I did not see the lamp at the Centennial; but as a matter of early history in regard to the arc light industry in this country, I did see an arc lamp run in Boston in 1865. That, however, was not to be called commercial in the sense in which you use it to-day. It was an arc lamp with clock-work-feed.

Mr. Lockwood: While I did not see any lamp at the Centennial, I will state that Mr. Frank B. Rae, of Detroit, will give the gentleman the information he wants. My reason for thinking so is that Mr. Rae gave me not long ago an account of an interesting experiment he made at the Centennial. He found that by making a flat helix of fine wire and connecting it with the receiver of a telephone, he could approach a dynamo, and

before he got within, say, five or six feet, and sometimes fifteen or twenty, by holding it out ahead of him; and moving it through the air, he would get induction, and then by comparing that with the tones of a flute that he had that had been attuned to respond to a certain number of vibrations, he could tell the number of revolutions the dynamo was making, multiplied by the commutator sections. (Laughter.)

Mr. DE CAMP: That reminds me of a story of a man who went out west and found a very desirable site on which to settle, but he took the precaution to ask the man who was selling the place if there was any chills and fever there. He said no, but there is in the next county. He went to the next county and asked the same question, and they said the same thing. I have asked a hundred times about this lamp at the Centennial, and never saw the man that saw it.

Mr. F. S. TORRY, of Chicago: I will say that I saw that lamp in Philadelphia.

President WEEKS: The next order of business is, "How Our Paths may be made Paths of Peace," by Mr. Pope, of New York. This paper has been distributed to the members of the convention, and having been read by title, is now before you for discussion. There being no discussion on this paper, it will be passed. The next order of business will be a paper by Professor Elihu Thomson on "Safety and Safety Devices in Elecric Installations." The paper has been distributed to the delegates and the discussion upon it will be opened by Mr. Lockwood, of Detroit.

The following paper by Prof. Elihu Thomson was then read:

SAFETY AND SAFETY DEVICES IN ELECTRIC INSTALLATIONS.

The development of the electrical arts, particularly in the direction of lighting and motive power transmission, has, in the past few years, been very great. It has brought with it a demand for very much work of a novel character, as regards the details of plant and methods of installation. It has also entailed, in many cases, elements of risk to life, and danger of fire. How far these risks have been, or can be, removed by proper attention to details and care in installation, has become an important subject for discussion. How far such risks have been increased by reckless installation of conductors, by faulty materials and supervision, is not easy to determine. There can be no doubt, however, that electricity, as an agent, in itself is not to be charged with bringing about the results for which recklessness in its use is sufficient to account. That under favorable conditions for discharge through a person's body, electric currents of comparatively high pressure may injure or kill, is not to be questioned for a moment. I have no sympathy with any effort tending to impress a false estimate of such risks, or tending to give the impression that they are absent, when in reality they are existent. I have no sympathy with any efforts to exaggerate such risks, efforts which have not been wanting, indeed, as is well known. The fire risk, as well as the personal risk, involved in electrical work is present in a greater or less degree, in accordance with the perfection of the work of installation and maintenance, the provision of the proper safeguards, and selection of the best conditions.

These are matters which are, every day, of growing importance in all the electric industries, not even excepting telephonic systems and other such work, which, if badly arranged and not properly maintained, may cause crosses due to failing wires, etc., to become sources of danger, trouble and annoyance in the distribution of lighting or other currents. There is one fact which is of the greatest importance in this connection, and it is that safe installation means, also, good service. There can be no question that the risk to life *from shocks*, even with bad work, would be removed by not using high potential currents, as they are called, either alternating or direct. There can be no question, also, that a shock obtained from certain characters of current, such as an alternating current, is much less safe than in the case of continuous currents of equivalent pressures. Nevertheless, I am just as firmly convinced that the fire risk is very much less with alternating than with continuous currents of equivalent potential, assuming the work of installation equally good. The fact that it is difficult to sustain an arc, or rather that it is easy to select conditions which will prevent arcs forming with the alternating system, as compared with the continuous current systems of much less potential, is greatly in favor of the former. Hence switches, fuses, bad joints, ruptured wires, are much less liable to arc and incur risk of fire with alternating than with continuous currents. Would it be possible to work successfully, using only low potential currents of either character? Would we be able to utilize water powers for lighting, without employing pressure of potential sufficient to convey the energy to a distance over a conductor of moderate or non-prohibitive cost? In most cases we would certainly not be so able. Again, to utilize water frontage for cheap coal supply, and to employ compound condensing engines, to insure small running expenses by massing the machinery at one station, to make use of railroad facilities, etc., in short, to work under the most advantageous operative and economical conditions, we *must* convey electrical energy by moderately high electric pressures, so as to avoid prohibitive losses or prohibitive cost of conducting wires. If ever our great natural resources in water powers are to be developed and utilized, it will be by the employment of comparatively great electric pressures for conveyance of energy to distant points. If great saving of cost of fuel and other expenses in operating one large steam plant, instead of a number of separate plants, with their attendant risks, in large cities, is an object worth seeking, it will be found in the conveyance of electric energy at fairly high pressures. It must not be forgotten in this connection that even with very low pressure currents, safety from fire risk is only to be secured by careful construction and supervision, and that risk of fire often involves personal risk. Subway and underground conductors have caused manhole explosions, with both low and high potential currents. Such accidents are generally explained by accumulations of coal gas formed in the manhole and subsequently fired by the electric arc or spark of a leak. This may be, and probably is, sufficient explanation, but another may be given—the evidence of the possible correctness of which I have witnessed. A heavy leak or overheating occurring at some point of the conductors near the manhole may generate directly a large volume of inflammable gas from the distillation of asphaltum or other substance used as an insulator, and this gas, mixing with the air of the manhole, may be easily fired by the heat of an arc or spark subsequently to its production, and cause a violent explosion. The remedy is thorough and continuous ventilation of the spaces in the manhole and subway. An instance of a storage battery car being wrecked, from a similar cause, is on record. In this case the battery conductors were probably overheated by a short circuit, and filled the compartment in which the batteries were with inflammable gases, and the further heating fired the mixture, the result being a violent explosion which greatly damaged the car. Such accidents always involve personal risks, and are to be prevented by simple means properly applied.

But the popular mind is so used to gas explosions that the newspapers have only a few lines to devote to them, while an accident in which an electric shock is obtained, although it has taken place through disregard of some simple precaution, is more than likely to be copiously provided with head lines and harrowing details. I even find one of the journals, whose name states its scientific character, attributing both the Lynn and Boston fires to electric wires. There is on exhibition at Lynn, as a curiosity, the oil stove which caused the fire, and inquiry into the cause of the Boston fire has, so far as I can learn, rather tended to discredit the theory than to confirm it. Notwithstanding these facts, it is true that under faulty conditions of lines or plant fires may arise, and hitherto have arisen, traceable directly to the heating effects of electric currents. Perhaps if the accidents which happen serve to enforce the fact that the best work, the most thorough provision for emergencies, and careful consideration of details of electric work will be requisite to secure proper safety in the electrical field as in other classes of work, their mission will be fulfilled. Severe and inconsiderate as has been the dealing with the wire question by the authorities in New York City, yet it cannot be denied that the condition of the overhead circuits there had been in the past few years going from very bad to much worse. In many cases considerations of safe working would seem to have been neglected in the competition for business. The lines of four or five different companies competing in the same territory might be found, the result of this condition being, without doubt, to enormously increase the risks. There have been hints of the coupling up of dynamos in series, and so increasing the potential of lines already worked at too high pressures in relation to their condition of insulation, and to the placing of the lamps or other work supplied from such lines. Along with this we find the air full of telephone, telegraph and signal wires of various sorts, none too secure from rusting out or breaking. Many of these latter wires could, no doubt, be easily buried underground, with advantage to the service, but it is certain that to attempt to bury the electric light wires in a hasty, ill-considered fashion, merely for the sake of getting rid of overhead lines, would be productive of no good results, either in avoiding risks or bettering the service. The placing underground of very many of the wires now found overhead in our large cities is, in my opinion, a matter which must come in time, but it should be done carefully and gradually, so as to secure the best work. Meanwhile the reorganization of existing wires, the removal of unused wires or redundant wires, as where two systems or circuits in the same territory overlap while serving substantially the same purpose of supply, and the use of first-class insulation on the wires would go far to securing safe working and uniformly good service. Besides all these precautions, and outside of them, wherever the conditions are and have been favorable to safe installation of overhead or underground circuits, there are to be found a class of appliances which are called "Safety Devices," inasmuch as it is their purpose to provide for abnormal conditions and remove risks which, with perfect working and maintenance, are usually absent, but may be brought into existence by accident or unforeseen defects. Such risks may be by outside interference with lines, or by lightning, by falling of poorly constructed signal and other wires upon overhead wires, by unusual wind or sleet storms, by failures of all kinds, as in the working of lamps, switches, etc. It is here that the safety device is found to be useful. Such devices are to the electrical systems what check valves, overflows, traps and safety valves, are to hydraulic systems. There is, of course, no room for doubt that if the insulation of all parts of the plant, as dynamos, lines, lamps, etc., were maintained always at its best, and if the mechanical strength of lines, hangers, poles, etc., could be always relied upon, and further, if the effects of lightning induction were never present, there would be but little use for any purely electrical safety appliances, such as those for guarding against leaks and diversions of current. To expect such perfection of conditions is to expect too much. A rigid system of frequent testing can, however, go far to anticipate and to discover the departures from such safe conditions, and enable the disturbing conditions to be removed. Nevertheless, there will always remain opportunity for unskilled or careless handling so altering the condition as to provoke trouble; there will always remain chances of undiscovered defects, chances of interference from outside. The effects of lightning are an important factor during the thunderstorm season. I am driven to conclude, therefore, that safety devices are, and will continue to be, important factors in electric work. The more thoroughly they are adapted to their intended functions, the greater the security, and the more extended their application. That system of distribution will surely survive, which, while involving economy of first cost and maintenance, at the same time secures the greater safety and embodies the greatest flexibility. I assume, of course, that the running economy is practically good in every case.

In the very early days of arc lighting, with a single lamp only on a circuit, the idea of safety from fire or shock did not present itself. When such lamps begun to be run in a series of eight or ten, or more, the need of an efficient cut-out was felt, so that a defective lamp failing to feed its carbons should not burn with a long arc or flame, and so involve risk or fire, or extinguish the other lights. This need was met in 1876, by Lontin, who used the shunt circuit to actuate a shunting switch around the defective lamp. The Brush cut-out followed, and was a decided improvement on Lontin. Fuller and others early went over the same ground. The film cut-out, or shunting switch, depending on a small thickness of a high resistance insulator, such as oiled paper, to prevent its closure, which paper film is overcome by the difference of potential or pressure between the carbons when a long arc forms, was brought out by the writer, and later, the "vacuum cut-out," a modification which rendered the device self-setting for repeated action if needed. It is scarcely necessary to add that spark-catchers and inclosing globes with wire nettings, were early additions to arc lamps to prevent sparks reaching inflammable material near by, and the globe also in addition served to diffuse the light. Current regulators were additions to arc machines, and acted to prevent undue current, and secure thereby not only safety, but good service. The fact that good service in most cases is assisted by appliances which insure the safety, or is even dependent on them, is a fact which ought not to be lost sight of in connection with the general subject of electric installation.

The early installations for arc light in and out of buildings, were made with bare wire circuits, and it is a satisfaction to me to recall in these days of forgetfulness of the benefits conferred by electric industries, and exaggeration of the dangers of properly installed plants, a case which occurred in connection with one of the earliest commercial plants of the Thomson-Houston arc lights in 1879. The machine, of about eight or nine lights capacity, with bare wire lines, was put up in a large brewery in Philadelphia, two arc lights lighting the stables in which were thirty or more valuable horses. One evening a fire started in the hay-lofts in the story above, and where there were no lights of any kind used, and soon the flame and smoke spread to the stable room and menaced the horses. The proprietor happened to think to start up the electric lights at this juncture. Their brilliant rays saved the animals, which were removed without trouble, and the lights were kept burning during the progress of the fire. Its spread was limited by the efficient work of the fire department. The arc lamp globes were at times full of water, but, to the surprise of the firemen, the lights were not extinguished, but assisted them in their efforts very materially.

As the number of arc lights placed in the circuit grew, the necessity for thorough insulation was appreciated; the effort to secure which, for arc lighting lines, has resulted in very great improvements being made in the past few years. So far as electric wires go the best "safety device" is a perfect insulation. In order that this matter shall not assume the condition of a trial of strength between armor and armor-piercing, as in naval affairs, with a constant growth of both, the advantage always being on the side of armor piercing or insulation-piercing, I think that efforts to run more than a certain limited number of arc lights in series should be discouraged. Eighty or one hundred lights, or even more, have been run and could doubtless be run safely under favorable conditions, but I doubt that such conditions can be found in city work; the interfering actions are too numerous, while the maintenance of good conditions would be too expensive. Without such good conditions, there would be grave dangers involved.

It has become a practice to use incandescent lamps of low resistance in series on arc light circuits or other constant current lines and much useful work is so accomplished. Here, again, safety from fire risk depends on certain safety devices, the most important of which is the shunt-forming device, when the carbon lamp conductor breaks. A number of very simple and effective devices are employed for this shunting action. Without such devices the tendency to arcing would be very great. It is advisable also not to rely on any one device alone for this purpose, especially if the lights are used indoors. Here the film cut-outs may supplement the action of a shunting device operated by the heat of an arc set up when the lamp carbon becomes discontinuous. These latter are the fusing cut-outs, twisted wire cut-outs, and others which connect the lamp wires together in the lamp, and so form a complete shunt. Other forms exist, notably the third wire cut-out, acting by diversion of current from the arc to a third or intermediate wire between the lamp conductors.

As is the case of the other devices mentioned, the perfection of operation of one, or a combination of several of these shunting contrivances, conduces not only to uniform service but to absence of risk. Absolute cut-off switches are now in common, if not in universal, use to cut-out loops of serious circuits, and in a measure may therefore be regarded as safety devices, but not of an automatic character. Outside of these factors just mentioned, safety in such circuits rests in insulation and maintenance, avoidance of leaks, or crosses, proper placing of wires and lamps, avoidance of partial contacts or partial ruptures of the circuit at joints, binding posts or switches. In series circuits the main object is to avoid a concentration of, or establishment of, large differences of potential at points in the line where the currents find or can find a path; in low potential, multiple arc systems as used in direct incandescent work, the object is to avoid concentration of current at points where such current cannot find a sufficiently low resistance path. Hence there are required cut-offs for an excessive current in any part of the system. Short circuits of accidental character must be provided against. If the safeguards are not ample, a more potent fire producer than a short-circuited section of an extended multiple arc system, is hard to find. Take out your fuse wires and replace them with copper wires, a practice, instances of which were not difficult to find in times past, and a short circuit may quickly heat a long line of wire in a building, so as to set fire to the insulation of the wire and surrounding woodwork. The fusible wire cut-out, if properly made and used, is an effective preventative of such risks, though magnetic cut-offs are preferred by some, though more expensive. The magnetic cut-offs, which are simply open-circuiting switches, controlled by magnets in the branch or line so as to open it on excessive current, have the advantages of promptness, avoidance of the scattering about of fused metal, and can be reset without any renewal of material; so differing from the case of a fuse wire. Another risk in such systems is that of creeping of current from main to main over moist surfaces, or partial conductors, in amount insufficient to blow a fuse, but sufficient to convert enough energy into heat to set a fire. Good waterproof insulation of wires avoids this risk if the insulation remains intact. I consider the plan of running the two branch wires, excepting the larger ones of the system, near together or close together, as excellent in avoiding this risk, provided the wires are encased in insulation and covered in, or run in a tube. In case of a leak from main to main, the more quickly the fuses blow, the better, and the proximity of the wires assists this speedy action, while between the wires there is not at any time enough combustible matter to set afire by the short circuit. Enclosure in a tube effectually shuts off possibility of flame reaching combustible matter before the fuse blows. This does not apply to the heavier mains, capable of carrying thousands of ampères, so well as it does to the smaller branches. I am glad to note here that the tube or conduit system appears to be well worked out for inside wiring by the Interior Electrical Conduit Company.

Another thing to be avoided in extended systems of multiple arc work is grounding or leakage to ground of current over resisting surfaces or materials. The tube system is useful here as well, and the placing of two wires at difference of potential, near together assists somewhat, but does not entirely remove liability of grounding. Testing for grounds in the system, taken in sections, is the proper procedure, although this does not provide against all suddenly formed leaks. It may be argued that in this case two grounds are necessary to cause a leak, one on each side of the system, and this is true, but in very extended systems of overhead work, more or less general leak exists which may provide sufficient current to feed, as it were, a local leak to ground from either main.

Let us now deal with what is called the alternating, or induction system of supply, in which the local or house mains, are separate from the primary mains, and of much lower potential. For lighting purposes the system is very flexible, and enables distance to be overcome. The secondary circuit is, or should be, entirely out of connection with the primary mains of high potential, and the potential differences of the secondary circuit may be so low as to be incapable of giving a severe shock under the conditions of use, and to be almost incapable of setting afire, on account of the absence of arc-forming tendencies. This is, indeed, an important factor in alternating current work, and conduces to the perfect working of switches and cut-outs, and the prevention of diversion to ground. Good work is all that is needed in this case to abolish all risks, if we leave out the main high potential current. The local line is unaffected by leaks or grounds at other parts of the system, and is, therefore, in this respect, in a better condition than is found with the consumer's lines in any direct system of supply. On the other hand, all the cases in which persons have received a shock from an alternating current of 1,000 volts or upwards, without being killed, are fortunate accidents, for there cannot be the slightest doubt that such current can, and will, kill under conditions favorable to its passage through the body. There are many cases of severe shocks having been obtained from such currents without permanent injury. On the other hand, there is a sufficient number of fatalities on record to sustain the position taken. The risks with higher than 1,000 volts alternating current are, of course, greater. It must not be forgotten, in this connection, that the actual poten-

tial differences in an alternating current of 1,000 volts are higher than that figure, and may be, at every wave, upwards of twice as much. This confers on such currents an actual and measurable striking distance between the two mains. As with arc lighting lines, the main or primary wires, if overhead, require to be kept thoroughly insulated and free from leaks to ground. The covering for the wire should be capable of resisting moisture, and the wire used be strong enough to prevent any possible breakage. If the primary wires break and come down, they are still kept charged from the dynamo, which is not always the case with arc light lines. If, however, the insulation is strong and perfectly good, the risk to life is small in such case. There is one fact I wish to impress, however, and it is, that with a perfectly insulated set of alternating primary mains feeding transformers, there still remains the static capacity of the line or cables and transformers, and this may be of an amount sufficient, if a person is grounded and touching the primary line, uninsulated, to give a severe if not a fatal shock. This inductive shock or discharge is, of course, far more pronounced with ordinary underground conductors than with aerial lines, and increases with the size and number of transformers and the extent of the line. It also increases as the voltage of the primary line is increased. Hence, it is quite important that no leak or connection exist between the primary line and a secondary in such system, or otherwise there may be a transfer of potentials of the primary line to the secondary so as to involve risk of shock to the consumer, or risk of fire from leaks to ground indoors. It will not do to say that such connections do not often form, for they may form from defects in construction, from moisture, and particularly from lightning discharges. A person standing on a damp floor, leaning on a steam radiator, touching a gas pipe grounded, or in other ways, may, if he handles or touches the secondary line at any part of it, be in peril of severe, if not fatal, shock. What was without this condition a most harmless local line, becomes most dangerous.

The writer early recognized this danger, and felt that unless it was provided for, the induction system was not advisable for general use. As a consequence, the expedients of grounding the secondary, or of surrounding the secondary by a grounded sheath, or of cutting off absolutely by automatic means the local line when connected with the main line, or of automatic grounding of the secondary by insulating films or spaces which are punctured or overcome by the the potential of the primary when connected with the secondary, were devised as safety devices. The grounding of the secondary is the most simple and effective if good grounds be made. It must, however, be done with certain precautions to insure the best results.

The second expedient of a grounded metallic sheath between the primary and secondary is persistently called "Kent's sheath" when alluded to by our English cousins, despite the fact that it is American in its origin. It is effective as a protector, as it carries to ground any discharge leaving the primary before it reaches the secondary. The sheath is easily made by placing a somewhat open wrapping around either the primary coil or the secondary coil of the transformer made of flat metallic ribbon or insulated wire, the ends of which are grounded when in use. The course taken by the wrapping is around the wire of the coils at right angles to its direction of winding. The automatic absolute cutting off of the connection between the transformer coils is also effective, and has undergone several modifications in other hands. The last protective device mentioned above leaves the secondary insulated from the ground until a contact or leak from the primary takes place, when an automatic ground is made. One of the forms consists in the interposition between the ground and the secondary coil or line of a film cut-out, or thin paper film between two metal buttons pressed together, one button connected with the ground the other with the transformer secondary. This device is very effective in securing a safety ground connection of the secondary when the primary leaks to it. A well constructed transformer properly installed will not, except by accident, lose its insulation between primary and secondary, and such insulation should always be many times that otherwise requisite, so as to have a margin of safety; but the safety device is none the less a necessity in its use.

I consider that a properly arranged double wire cable, well insulated, constituting the primary line, laid in ventilated pipes underground, transformers connected therewith, also inclosed in a grounded metal case, in the cellar of a building, a secondary line of low potential, grounded, or provided with safety devices as mentioned, embodies as safe a system of incandescent electric light distribution as can be devised, both as to risk to life and danger of fire. It insures complete safety to all the consumers and to each one individually. It enables long distance work to be undertaken, and allows low voltage lamps to be used with their increased economy. The risks are confined to the electric station and the primary lines which should be handled by men who know their business. The non-commutation of the current at the generators is another advantage, of course. The disturbing influences, which in the best organized plant may be introduced by lightning, are serious and sometimes destructive. It is not that the lines are struck by lightning in causing such troubles, but the mere *inductive* current or discharge from a flash of lightning is quite sufficient. It puts upon the line potentials of many thousands of volts and tends to break down insulation everywhere. Lightning arresters are therefore important safety devices in more senses than one. They save the machines in the station and the apparatus outside. In the alternating system they save from puncture the insulation between primary and secondary coils of transformers and between the turns of the primary coil itself. Every plant then, should, if subject to lightning induction, be provided with efficient lightning arresters or dischargers.

A discussion of this general subject, however brief and necessarily restricted in scope, would be very incomplete without allusion to the subject of contact with telephone or telegraph wires with electric light conductors. Under ground and in conduits such contacts could not easily occur, though leaks might readily take place between lighting conductors and other wires. In any case, there is a risk of such wires carrying current into buildings or to positions bringing about shocks to persons, thus involving risk of fire or danger to life, or both. As a consequence a set of safety devices have been brought out under various names whose purpose is to cut off dangerous currents when they reach or traverse lines, such as those of the telephone and telegraph. It is my opinion that in cities the provision of approved devices of this kind should be compulsory. Most of those which I have seen are not well enough designed or made to be perfectly relied upon, but are much better than nothing and may possibly suffice. Such apparatus, however, should be made so as to be perfectly reliable and undergo a regular inspection. Mere fuses, even if made long, are not enough. There should be placed in every circuit liable to contact with lighting or such like conductors and at a place in the circuit where it enters a building, a protective device which, to be complete, should shunt or absolutely cut off the section of wire indoors, or ground the same in case of abnormal current on the wire or abnormal potential.

There is much more to be said on this subject, and I am conscious of only having touched upon certain important matters in this paper. If I have succeeded in pointing the way to better conditions in any case, I shall be more than satisfied.

To sum up briefly, safety in outside work means care in placing, maintaining and insulating conductors, whether used overhead or below ground. This means the employment of only good linemen, and not men who are ready to incur risks through a reckless disregard of conditions of failure to comprehend their importance. Men who have done telephone or telegraph line work are not necessarily prepared to undertake electric light and such other work with the best success. Safety in inside work means, primarily, if admissible, separation of the inside circuit absolutely from the general supply mains, and in any case it means that good, careful workmanship is requisite, and that the employment of safety devices, amply sufficient to do the work required of them in case of accident, is imperative.

Safety from current entering buildings upon telephone, telegraph and other wires, means first, a more systematic placing of such lines apart from electric mains, whether above ground or below, guard wires and insulated wire for such lines; stronger wire, especially for telephones, and the employment of safety devices in case of accidental leaks or crosses occurring with electric mains of either low or high potentials, and a periodical inspection by proper officers.

Mr. Lockwood: I have had but very little time to study this paper of Professor Thomson's. I am sure that every member of this convention must feel in the present condition of electric lighting the need of safety devices. I hope that by the time this convention adjourns we will all get ideas enough regarding all possible means for safety, so that when the next annual convention meets we will have a year's record that will compare with any record that could be asked for. I do not want to be understood that I am now using in my station every device that I advocate, because I am not. But they will all go in there as soon as I can get them in, and do the work thoroughly, and from that period I am going to keep our station in the matter of safety devices at the head of the list as far as lies in my power. On this question of lightning arresters it is not so much a question of preventing accidents to the employés and to the public—I do not think it is as necessary as some other devices—but it is one of the simplest and best things that can be provided for safety with our present knowledge.

Professor Thomson speaks of the advantage of using high potential as a measure of economy in fuel and other expenses. I think that we all agree that the more we can centralize our work, the cheaper we will be able to operate our lamps, and the more carefully can we supervise the work that is being done and maintain everything at the proper standard. He speaks of the fact that in dealing with the underground wire question, the authorities in New York city, have been very severe, but yet thinks that it will lead to final benefit to the electrical interests. I think the question as to whether that would be so or not depends upon no one thing more than how we keep our circuits supplied with safety devices from this time forth. I think that this will do more to solve that question than anything else. I think if we do not pay careful attention to adopting means for denoting a ground when it occurs on a circuit, and then locating it and finding how it can be removed in the shortest possible time, and seeing that in all ways our circuits are kept clear and free, we cannot expect the success that we should have.

Mr. Law: In the matter of lightning arresters, I think we have a very important species of safety devices for central station work. Not only does it protect the dynamos, but it protects the insurance companies against loss by fire. Before the adoption of lightning arresters in our station in Philadelphia, we had three fires in buildings in different sections of the town which were caused by lightning coming in on our lines, but since the introduction of lightning arresters we have lost no dynamos and have had no fires. Another important feature of lightning arresters is their protection to underground cables in taking up the so-called static discharge of the dynamo on the interruption of the circuit. I find it very valuable in that respect. The matter of cut-out boxes is another very important feature, and they should be placed on every part of the circuit where it goes inside of a building or is attached to a building or a loop going over any street; it gives you perfect control of that circuit in case of fire. That was very clearly demonstrated to me about two months ago at a fire we had in Philadelphia. I was at the fire very soon after the alarm, and found we had a loop going up in the rear of the building. I discovered there was no box upon that pole, for which my foreman received very severe censure. I was obliged to put in a cut-out to cut those wires loose. Had I had a cut-out box there it could have been done much quicker and much more safely.

Capt. William Brophy.—I wish some one who had better control of the king's English than I could do justice to the barbarous treatment the electrical fraternity have received at the hands of the so-called Underground Commission of New York. (Applause.) I cannot do justice to to the subject. I agree with Professor Thomson in all he says with regard to that subject. A few men selected without any regard to their qualifications for the positions they hold, sit in judgment and throw a large city into total darkness without naming any provision for any other form of light, and, as it were, turn the whole city over to the hands of thugs and criminals. I believe myself that the insulation of overhead wires is only a question of dollars and cents saved to the parties who are operating the central station. I do not believe it solves the problem of preventing accidents to life and accidents by fire. An unused wire that no one cares about can drop down and saw its way through the insulation of another wire in half an hour, and some one will come along and complete the circuit from the wire to the ground and be the victim, and the press spreads the news all over the land, giving no explanation of how or why it was done. So far as safety to the public is concerned, if you will run your wires well up in the air, if you can get the right of way to do so, it matters little whether they are bare or insulated; but if you want to carry on a successful business, it is your duty to properly insulate your wires. Until the municipalities or some other power will protect you from the tram wire, the poorly constructed wire, and the many other roads through which death and destruction may be carried as they are, you cannot be held responsible for these accidents; and until you have the right and the clear right to run your wires without being menaced by such things as these, you cannot prevent accidents of this kind. (Applause).

The President: If there is no further discussion on the topic, it will be passed with the usual instructions to the secretary. There being none, it is so ordered.

The next order of business will be the report of the Committee on Electrical Data.

Mr. DeCamp: I am not the chairman of that committee. Mr. Foote is the chairman, but I submit the report, and will ask the secretary to read it.

The secretary then read the report of the Committee on Data as follows:

REPORT OF THE COMMITTEE ON DATA.

Membership.

1. The membership of the committee as now constituted is as follows: 1, A. J. De Camp; 2, C. R. Huntley; 3, E. F. Peck; 4, Edwin R. Weeks; 5, Allen R. Foote (Chairman).

Work Done.

2. This committee has printed in pamphlet form and distributed to central station companies, the paper read at the tenth semi-annual convention of the Association on "The Value of Economic Data to the Electrical Industry." Accompanying this pamphlet a circular of inquiry was sent, inviting the suggestions as to the items of data which those addressed considered desirable to be collected; also the form of accounts, reports, which may be used to establish a uniform system of accounts, with a view of rendering the data obtained from them reliable and valuable.

3. The responsives received, by correspondence and personal interviews, leave no doubt in the minds of the committee as to the general appreciation of the value of the work to be undertaken and of the cordial co-operation of central station companies in carrying it to a successful consummation.

Census Data.

4. In view of the fact that the United States Census office is now engaged in preparing schedules for obtaining certain data relating to the electrical industry, this committee think it best to suspend the work of formulating reports for the purpose of obtaining data until after the work of the census office shall have been officially published. The committee can then devise such report as may be supplementary to, or a continuation of the work done by the census office, thus increasing very greatly the value of the work it may do.

5. With the above object in view the committee has given special attention to the work of assisting the formulation of a special schedule for central station companies for the use of the Census office. The outlines of this schedule have been submitted for suggestion to upward of thirty of the largest companies in the country. A representative of each company has gone over the entire subject in detail individually, and made the suggestions as seemed to him to be pertinent. The entire schedule is now in process of revision in the light of these suggestions. When this work is accomplished it will be again reviewed by this committee. In case the schedule as then submitted is satisfactory, this committee requests the authority of the association to approve of the schedule in the name of the association.

Theory Versus Facts.

6. The first decade of the history of the electrical industry was necessarily the decade of the theory and experiment—a decade in which large sums of money have been invested, on the basis of representation made by manufacturers as to what their apparatus or construction was expected to do. During this period, the time of the conventions of this association has been largely consumed by long, and sometimes exciting discussions, over this or that feature of the business in which all were engaged. No satisfactory solution has been reached by such discussions, because arguments were based on what was expected to be, instead of upon what was.

7. In entering upon the first year of the second decade of electric light history, it will be well for the association to draw a sharp line of demarcation and cease to discuss subjects from the standpoint of theory. It should substitute therefor the standpoint of facts. Not that the days of theory and experiment are over; that will never be. But the days are over when, to have an electrical service at all, it must be accepted on faith in promised results. The time has come when we can afford to wait for the adoption of a new idea, or new application of an old idea, until it has been put into practical use for sufficient time to enable their claim for general adoption to be based on accomplished results.

Mr. DeCamp moved that the report of the committee be received and the committee continued, with such changes in the membership of the committee or additions as he should think it was good to make. This motion was carried.

Secretary Garratt: In the seventh clause of the report it says, "Entering upon the first year of the second decade of electrical history." I think that should be amended so as to say electric light history. Electrical history runs back several centuries.

Mr. DeCamp: I want to submit as supplemented to the report we have just received the following resolution.

The resolution offered by Mr. DeCamp was then read by the secretary as follows:

THE INVESTIGATION OF THE ELECTRICAL INDUSTRY FOR THE UNITED STATES CENSUS OFFICE.

Whereas, The superintendent of the United States Census has appointed a special agent for the investigation of manufactures of electrical apparatus and supplies and their uses; and,

Whereas, This is the first official investigation that has ever been made of this subject in this or any other country; and,

Whereas, It is the opinion of this association that such an investigation will be of the very highest value as a means of furnishing the public with information that it can accept as being reliable, impartial and authoritative, and for that reason will be of great value to those interested in the electrical industry; and

Whereas, This association, in behalf of the electrical industry of the United States, desires this investigation to be thorough and complete in every detail, and is aware that such an investigation could not have been fully authorized and provided for, on account of the newness of the industry, when the law providing for the census of 1890 was enacted—

Be it Resolved, by the National Electric Light Association, in convention assembled,

First. That it respectfully petitions the Senate and House of Representatives of the United States Congress to authorize and direct the superintendent of census to collect the following data in relation to the electrical industry, in addition to the general statistics of manufactures already provided for by law.

(*a*). Details pertaining to underground and aerial construction, underground and aerial currents, the character and voltage of all currents and their uses; lamps in use, arc and incandescent, and how wired for residence, commercial and municipal service; motors for use for stationery service and motor cars, income and expenses, etc.

(*b*) An inquiry through sources independent of those interested in the industry, as to the casualties resulting from the use of electric currents, both as to fire and personal injuries. This investigation to be made in all cities of 10,000 population and over. The information to be obtained from underwriters, the records of fire departments, coroners' statistics, health boards or commissioners, or from whatever source of information that may exist in any city. The investigation to make a comparative statement between the casualties resulting from the use of electric currents, and the use of other agents employed for similar purposes.

Second.—That we hereby petition that an appropriation of not exceeding $50,000 be made for the purpose of this investigation.

Third.—That the National Electric Light Association hereby tenders its thanks to the Hon. Robert P. Porter, Superintendent of Census, for the recognition he has given to the importance of, and wonderful progress made by the electrical industry, by the appointment of a special agent for its investigation, and we hereby pledge our cordial co-operation with the Census Office in its efforts to make the investigation thorough, reliable and complete in every detail.

Fourth.—That a copy of this preamble and resolutions be properly engrossed, officially signed by the president and secretary of the association, and transmitted to the chairman of the Committees on Census of the Senate and of the House of Representatives, and to Hon. Robert P. Porter, Superintendent of Census.

Mr. DECAMP: In order that you may understand the purpose of this resolution, I will state that there has been a kindly and co-operative disposition on the part of the census department to separate our branch of industry and make it a special section, but it has certainly proven to be true that the chief of the department did not contemplate the scope of the work to be done. To be of value it must be done thoroughly. I am rather inclined to think that the form of blank, etc., that would be necessary involved more expense than the chief of the census department contemplated when he first took the matter up. However, there seems to be no doubt but that this additional appropriation can be secured; but out of courtesy to the chief of the department, if nothing else, as he has taken an interest in it so far, we ought to back him up with the strongest petition we can possibly present. In addition to this resolution petitions have been sent out for signatures to some two thousand people. I sent in a very strong petition from Philadelphia, and we sent a copy to many places accompanied with a blank petition. Many of you may not have received these petitions, but if you have not, you will receive them when you return home, and I wish you would return those petitions if they are signed by only one or two. This should be done promptly, because we have got to work promptly if we do not wish to fail in this work of initiating an electrical department, and doing it well at the send off.

Mr. Mason moved the adoption of the resolution.

Mr. CLOWER, of Texas: I am not a member of the association, but I would like to suggest that the resolution should apply to cities of 5,000 inhabitants as well as 10,000.

President WEEKS: The gentleman is not a member of the association, but the committee may accept his suggestion.

Mr. DECAMP: The resolution is before the association as formulated by the committee, and I would not like to alter it on my individual responsibility. I think the $50,000 will hardly cover the ground of the work as it should be conducted in the cities named in the resolution.

The motion of Mr. Mason to adopt the resolution was then put and unanimously carried.

Mr. Lawrence, of Cleveland, then offered a resolution which was handed to the Secretary.

Mr. F. A. Wynn, rose to the point of order that all resolutions should go to the Executive Committee and be approved by them before being presented to the association.

The President announced that the resolution was referred to the Executive Committee.

Mr. DECAMP: On what rule of the constitution is that based? A resolution is presented and you announce that it is referred to the Executive Committee.

The PRESIDENT: It is based on the provision of the construction that the executive committee shall arrange and provide for the programme and the order of exercises.

Secretary GARRATT: I am responsible for this coming in in this way. I was asked if it were appropriate for Mr. Lawrence to introduce a resolution, and I said that it was. If I am in error, I stand corrected. I told him to have the resolution drafted and either read it himself or hand it to the secretary.

Mr. MASON: Have you given us the only authority for your decision?

PRESIDENT WEEKS: That is the authority; yes, sir. There is in addition to that the authority that might be cited that it is submitted by an association member, and should come through an active member.

Mr. MASON: I understand that associate members have all the rights except those of voting, as recited in the constitution.

President WEEKS: The decision of the Chair is based upon the provision in the constitution. It is immaterial however, if it meets with the concurrence of the convention.

Mr. MASON: I would be glad to have that matter decided by the association, through an appeal from the decision of the Chair. I do not wish any disrespect in the appeal.

President WEEKS: Certainly not. My ruling was on the way the matter presented itself to me.

Mr. MASON: I appeal from the decision of the Chair. I think this question should be settled; it is a very important one and should be settled now. I do not think it was the intention of the association ever to repose in the executive committee such an exclusive power as this, that no business can get to this association except through the executive committee. If that is what is meant, let us know it.

President WEEKS: I do not understand that to be so. That is as to matters pertaining to the arrangement of programme and exercises. All matters must come through the executive committee—all such matters, as is distinctly stated by cur constitution.

Mr. MASON: Of course, we are all in the dark, I presume as to the character of this resolution, but I would like to have it decided whether a member of the association can present a resolution to the association direct, or whether it must go through the hands of the executive committee.

President WEEKS: I think it can be presented directly to the association, if there is no interference with the order of business upon the table. There being no interference in this case, I think I will have to reconsider the position taken upon that. (Applause.)

Mr. WYMAN: Mr. President. I rise to a question of privilege, and ask if it is not clearly stated in the constitution and by-laws that all papers and resolutions that are presented before the association shall pass through the hands of the executive committee?

President WEEKS: It does not state all papers. I will ask the secretary to read that sect on of the constitution.

Secretary GARRATT: I have not a copy of the constitution here, but I think I can set the gentleman right. The constitution states that it is the duty of the executive committee to examine "papers," but it does not state that all papers shall pass through their hands. It has been the practice of the association to have resolutions passed by way of the executive committee, so far as I know, but they do not of necessity go that way.

Mr. LOCKWOOD, of Detroit: I have here a copy of the new constitution, which you may have.

Secretary GARRATT: The constitution says that the executive committee shall be the governing body of the association; that it shall meet upon the call of its chairman from time to time, and shall report upon application for membership, shall gather proper information upon topics of interest and see they are arranged for discussion by the several members of the association. Five members of the committee shall constitute a quorum.

Mr. DECAMP: I may state that I have been a member of the executive committee, either direct or ex officio, ever since I have been connected with the association. I will enlighten the gentleman who has just spoken, as I see how he has been misled. The executive committee have been in the habit of revising the papers which have been presented, for the purpose of relieving the association of the cumbersome amount of papers to be read for discussion before the Convention. It has always been the case that there was more good material presented than it was possible for us to get through with; and, therefore, all such papers were referred to the executive committee to decide which were of the most general interest to the association.

Mr. WYMAN: I would like to ask the gentleman who was last up if it was not the feeling at Niagara Falls that all things should go before the executive committee, in order that advertising schemes should not be thrown on the association.

Mr. DECAMP: I presume if the resolution should take the form of an advertising scheme, the association is perfectly competent to sit down on it peremptorily.

Mr. ALEXANDER: Mr. President, if an associate member appeals from the decision of the chair, how do you decide that point? Can an associate member appeal from the decision of the chair?

President WEEKS: No, sir; I think not.

Mr. MASON: Does not the constitution recite that associate members shall have all privileges except those of voting.

President WEEKS: An appeal from the decision of the chair, is a privilege so nearly akin to that of voting, that in my opinion it comes under that exception.

The matter was presented by an active rather than an associate member. We will admit the resolution.

Mr. WYMAN: I move the resolution be laid on the table.

Mr. MASON: That cannot be done until it is read.

Under the direction of the President, Secretary Garratt read the resolution, which was as follows:

Whereas, The present classification of electric light carbons is much higher than other commodities of corresponding weight, bulk and liability to damage, packages less than car lots being rated as first class and carload lots as third class; and this classification was made years ago when few carbons were manufactured, when they were high-priced and supposed to be very liable to damage, but are now among the cheapest shipped, are compactly and securely packed, easily handled, and not liable to damage in the ordinary risks of transportation, which is demonstrated by the fact that no claim for breakage of, or damage to, carbons has ever been preferred to the railroad.

Therefore, Be it resolved that the National Electric Light Association in convention assembled, considers the present classification unjustly burdensome, and believes the interests of all electric light companies will be promoted by reducing the classification, and that greater volume of traffic and corresponding gain to the railroad companies will accrue.

And be it further resolved, That this association indorses the efforts of the committee of carbon manufacturers appointed to make application to the general freight classification committees of the United States in furtherance of this resolution.

Mr. MASON: I move the adoption of the resolution as read.—Carried.

Mr. HUNTLEY: I move you, Mr. President, that the chair appoint a committee of five on nomination of officers and place of meeting for the ensuing year, and that the committee so appointed be requested to report at the opening of the session to-morrow morning. Seconded; carried.

President WEEKS: I will appoint as a committee on nomination and place of meeting the following members: Mr. Huntley, Mr. Francisco, Mr. Peck, Mr. De Camp, and Mr. Beebe.

Mr. DECAMP: Mr. President, I move you that when this convention adjourns at Kansas City, it adjourns to meet in the month of August, 1890, at such date as the executive committee shall decide upon, at Cape May, New Jersey.

Colonel RANSOM: I desire to second that motion, and in doing so to state that I suppose you are all well aware where Cape May is. It is two hours' ride from Philadelphia and four from New York. There is at Cape May the Hotel Stockton, which has four hundred rooms, with a capacity for eight hundred persons, for the meeting of the association. There is also ample committee room, free of charge. There is a fine orchestra in the house during the summer to give concerts in the morning and hops in the evening. The Stockton is strictly first class. The rates, according to location of rooms, are $3, $3.50, $4 and $5 per day. There is also power for exhibition purposes, 140 h. p., which can be had free of charge. Col. Walton, the proprietor of the Stockton, came on from New York with us, and has been here a number of days, and we who know him best think we would like to be under his charge while at Cape May. Your resolution says nothing in regard to the Stockton, but to go Cape May is to go to the Stockton. I desire to second the motion of Mr. DeCamp. Carried.

Mr. MASON: I move we adjourn to 9:30 to-morrow morning, and that we may commence promptly in the morning.

The convention then adjourned, to meet at 9:30 the following morning.

FRIDAY MORNING SESSION.

Promptly at 9:30 A. M., President Weeks called the convention to order, secretary and treasurer A. V. Garratt at the secretary's desk.

The CHAIR: We have for the first business this morning a special order, which is the report of the committee on nominations of officers for the ensuing year. The chairman of that committee is Mr. C. Huntley.

Mr. Huntley presented the report of the committee as follows:

REPORT OF THE COMMITTEE ON NOMINATIONS.

For President, M. J. Perry, of Providence, R. I.
For First Vice-President, E. W. Maher, of Albany, N. Y.
For Second Vice-President, C. L. Edgar, of Boston, Mass.

C. R. Huntley, Buffalo, Mo., chairman. For Executive Committee, E. R. Weeks, Kansas, City, Mo.; James English, New Haven, Conn.; E. A. Armstrong, Camden, N. J.; M. D. Law, Philadelphia, Pa.; M. J. Francisco, Rutland, Vt.; A. F. Mason, Boston, Mass.; John A. Seely, New York; H. K. Thurber, New York. F. E.

President WEEKS: Gentlemen, the report of the Committee is before you; what is your pleasure.

Mr. A. F. MASON: I think that every member of this association recognizes, with something akin to gratitude, the very felicitous, the very remarkable service of the present president of this association. I believe that I do not speak for myself alone, but for every member of the association, whon I say that we have had an exceptionally profitable as well as enjoyable meeting here in Kansas City; and that very largely this is due to the efforts of our President, Mr. E. R. Weeks. I therefore, desire to put in nomination for the presidency of this association, for the ensuing year, Mr. E. R. Weeks, of Kansas City. (Applause.)

Mr. DECAMP: That nomination being made outside of the committee, I think it requires a second. I cannot do otherwise than second that nomination. Whatever we may be glad to do as a body of men, we certainly owe one thing, and that is a proper appreciation for those who have already served us. I think that I am justified in saying, of all the meetings that this association has had, of which I have attended, from step to step, there has been evidence of a healthy growth. But like the growth of our country, we have in that total growth made a rapid stride. The step from our last meeting to the present comes under that class—it is a stride. This is the most largely attended meeting that we have had. There has been the most interest taken in it, and our work has been of the most practical kind, and I think that it has been due very largely, if not entirely, to the efforts made by the president of this association. He has been during the last six months at work constantly, or results such as we see before us could not have been accomplished. I would be glad to have him fully appreciate the feelings of this association, as well as I know the association and its members individually appreciate the efforts of its officers in the past. I heartily second the nomination of Mr. Weeks as the president. (Applause.)

President WEEKS: Gentlemen, your action in this matter is gratifying to me, in that it evinces your approval of the administration just drawing to a close. Next to the consciousness of having done one's best comes the approval of one's friends and associates; but my views of the presidency of this association have not changed. It is my opinion that the President of the National Electric Light Association should be a citizen of one of the large Eastern cities, one of the great electric centres, if I may so speak, of the country, where he can carefully watch all movements affecting the interest of the industries that we represent. Kansas City is not such a centre, although Kansas City will some time undoubtedly be just such a place, and the place where, for this very reason, the president of some future convention of this association might well be located. It is not now so. I myself have during my administration felt frequently the disadvantage of distance; and if the interests represented in this association have not suffered, it has been due largely to the zeal and support of the Eastern members, it has been due largely to the vigilance of our secretary and the earnest watchfulness, to the zealous application and industry of our Eastern committee. The success of this convention, which has been so kindly attributed to me, is due very much more to the combined effort of these gentlemen who have supported the administration and have looked out for the association so carefully, than it is to your president. For these reasons I feel, much as I appreciate the honor that you offer me, that the best interests of the association require the election of the officers nominated by your committee. In the expression that has been made, and in the increasing prosperity of this association, in the strengthening of the association throughout the West, which was the reason for my acceptance of this office, I find my reward. I thank you for your offer, but for the reasons stated must respectfully decline the nomination. (Applause.)

A motion to substitute Mr. J. J. Burleigh in place of Judge Armstrong, was then put and unanimously carried.

Mr. PHELPS: I believe I am entirely in order to move you that the secretary be instructed to cast the ballot of the association for the officers and members of the executive committee as reported by the committee. If I am, I will make that motion.

President WEEKS: That is entirely in order.

The motion to instruct the secretary to cast the ballot of the association for the officers and members named in the report was then put and carried, and the Secretary cast the ballot.

President WEEKS: I declare the election of the following officers of the National Electric Light Association: *President*, Mr. Marsden J. Perry, of Providence, R. I.; *First Vice-President*, Edward N. Maher, of Albany, R. I.; *Second Vice-President*, C. L. Edgar, Boston, Mass. Upon the *Executive Committee:* C. R. Huntley, chairman, Buffalo, N. Y.; E. R. Weeks, Kansas City, Mo.; James English, Bridgeport, Conn.; J. J. Burleigh, Camden, N. J.; M. D. Law, Philadelphia, Pa.; M. J. Francisco, Rutland, Vt.; Dr. Mason, Boston, Mass.; John A. Seely, New York; H. K. Thurber, New York.

Mr. DECAMP: You read Mr. English's name as being from Bridgeport.

Secretary GARRATT: It is so written in the report; he is connected with the Bridgeport Electric Light Company, but he lives in New Haven. It is the James T. English whom we all know.

President WEEKS: The next order of business will be a discussion by Mr. Frank J. Sprague, of New York, on the subject of Electricity as Applied to Street Railways.

Mr. SPRAGUE then addressed the convention as follows:

APPLICATION OF ELECTRICITY TO STREET RAILWAYS.

Mr. PRESIDENT AND DELEGATES: Scarcely fifteen years—a period of time yet within the memory of the youngest of us—have passed since the beginning of a new era, the transmission of energy for light, power and the reproduction of speech. Of the progress of the first I need not speak, for the delegates of this convention are well cognizant of its history and the advance it has made within that time. The sperad

of the telephone to nearly every town and hamlet in the fourteen years since it was exhibited as a scientific toy at Philadelphia, and the financial success of the parent company, are facts continually before your minds or ringing in your ears. But that great industry, the transmission of electricity for power, with its possibilities of all kinds, is of very recent development. Six years ago there were scarcely a hundred electric motors in operation in the United States for any purpose; to-day there are no less than 15,000 motors in use, applied to not less than 200 different industries, and an industrial revolution is taking place equaling, if not surpassing, in importance that attending the introduction of the steam engine, and marvelous in the rapidity of its growth.

It is not my purpose to dwell at length upon the subject of the transmission of power by electricity in its general application, but to touch upon one branch only, that of railway work, reviewing very briefly the development in the United States, pointing out the salient features of successful operation, noting what has been already accomplished, and after some remarks upon the legal questions which have arisen, considering the possibilities of the future.

The modern electric railway may be said to have been born in Europe; its babyhood was in Europe; but in its youth and younger manhood it is purely American. In 1881, Dr. Siemens, of Berlin, established the pioneer railway on the Lichtenfelde line in the suburbs of Berlin, and I believe it is still running. It was followed by other roads, some commercial and others for exhibition, erected by the firm of Siemens, and by work done by other electrical engineers. The Siemens also established a line at Frankfort. The Doctors Hopkinson established one at Portrush, Ireland. Another was established at Blackpool. This last was a conduit system. A double metallic overhead system was establishe i in 1888 at Vevay, Switzerland, and comparatively recently the Siemens have established a conduit system at Buda Pesth.

The first line which was established in the United States for actual commercial service was a surburban line of two miles in length, built by Mr. Daft, just outside of Baltimore, in the latter part of 1885, using a central rail. Other lines were established by Mr. Vanderpoele in various parts of the country, using the single and double trolley system, with the trolley travelling upon and carried by the wire and connected to the car by a flexible cable.

In all this pioneer work the system used was that of direct supply, but most of the mechanical features as well as the electrical details have now given way to other and more efficient methods of operation.

Of the more recent work three classes demand attention, one being the system of independent units operated by the storage battery, and the other two being direct systems of supply, one underground, the other overhead. I shall not enter into details of these three systems or their modifications, for it would be a repetition of much which has already been written, but I will briefly state the facts, and the conclusion I have formed concerning them.

There is something exceedingly attractive in the proposed application of storage batteries to the propulsion of cars. To be able to conveniently store up a large amount of energy in a box, put it aboard a car, carry it around with us, and take from it a greater or less amount of work, offers, when practicable, a solution of the street car problem for which we are all devoutly hopeful. But look at it commercially. The storage battery is still a long ways from being a serious competitor of the direct source of supply. True, great improvements have been made in it, but these improvements have not very much altered its character, or the weight which is necessary, or the care which must be exercised in getting an economical return from the battery. These improvements have made it possible to take a heavier charge from the battery without producing buckling, have made a rougher usage of the battery mechanically possible, and have in some instances greatly reduced its cost of manufacture, so that the element of maintenance is a less serious one than it was a year or two ago; but the capacity of the battery, while it has been somewoat increased, remain such that it is still necessary to have about 3,500 pounds to propel an ordinary street car. This means an excessive weight. It takes up space and is a serious extra load to be carried around. It requires frequent shifting, and its capacity as well as discharge rate are so limited that it is simply impossible to work such a battery upon grades which are at all severe. I believe it is possible with care to operate a storage battery on grades not exceeding, say, four per cent., and with limited speed and daily mileage at an expense about equal to that of horses, or a little less, but still at about double the expense which is necessary upon a suitably erected and properly operated overhead system.

Nowhere in the United States, that I am aware of, is there serious storage battery work being done at the present moment. The nearest attempt was where recent experiments were made on the Madison Avenue Line, New York City, where about a dozen cars were being run up until eight o'clock in the evening, but owing to legal complications only two cars are now running there, —with what daily mileage I do not know. But nowhere is the work done at all equivalent to what is constantly practiced on the overhead line. On that service motor cars start out at five or six o'clock in the morning and run until midnight. Many cars make 150 or 160 miles a day, and some cars have even made 180 and 190 miles a day. Half of this for storage battery work is good duty, but it is not up to the demands which street railway managers make, and until the radical improvements which are promised are made in it, the field of application will be limited.

The conduit system of direct supply has been attempted in several places, notably at Denver, Cleveland, Allegheny City and Boston, but at all the places mentioned these experiments have proved disastrous and have been abandoned, save the short section at Allegheny City. In England, the Blackpool line, under special conditions, has been, I believe, fairly successful, and at Buda Pesth, the Messrs. Siemen have a conduit system in successful operation. There, however, the drainage is very perfect, and in addition a man is detailed for given sections of the track, and is continually employed in patrolling his section and clearing it out. Assuming good sewerage, the conduit can unquestionably be made to work. It becomes then a question of cost; but for general application, especially in view of the fact that most of our cities do not have a sewerage system which can take care of the street drainage, the expense is prohibitory save on large systems under exceptional conditions. I look forward to the time when many existing well constructed and well drained cable conduits will become electrical conduits, and electricity will then score another victory.

The system, however, which has made such a marked advance is the single trolley overhead system with universably flexible underneath contact, and this has been the growth of the past two and a half years. I think I can fairly claim for the Sprague Company the pioneer place in this development, but the commercial development on the lines it laid down has been with great energy pushed forward principally by both it and the Thomson-Houston companies. The first work done by the Sprague Company, other than experimental work on the elevated railroads, was made but a short distance from this city. A single car was started in 1887 on the Union Passenger Railway Company's line in St. Joseph, with a small 7½ h. p. motor, single geared, and adapted to run at a very high speed on a surburban extension. It is a matter of interest that that road has seen nearly every change made in the system. Its lines have been extended twice, and it has both the old style motors and the more modern equipments. But all the work done on that line was, it may be said, purely experimental, and it was not until the 2d of February that the Richmond road was officially opened to the public. I speak of this road, not so much because of my personal interest in it, but because it marked an era in the development of electric railways. A radical departure was made from the work which had been done prior to that time, not only in the amount and extent of the system equipped and the number of the machines operated, but also in the disposition and control of the machines, the system of overhead wiring, and the method of getting the current from the wire. The characteristics of that line are now pretty well known. It was a road of about twelve miles in length, with 30 curves, some of them of exceedingly short radius, with grades running as high as 10 per cent., and with a roadbed utterly unfit for the traffic which it had to support. The equipment was for forty cars, requiring 80 machines, and was to be operated from one central station. When first proposed the attempt was looked upon with a good deal of ridicule, not only by street railway men but by electricians themselves. The street railway men thought that the ordinary condition of street car service would make it impossible for a self-propeller car to ascend a grade exceeding five or six per cent.; and as for attempting a 10 per cent. grade, that was out of the bounds of reason. As regards the electrical problems, the motors, instead of being placed on the car body flexibly connected by chain gearing or belts to the axles, were placed underneath the car, and flexibly and concentrically geared to the axles. They were uncovered and exposed to the mud and moisture, and to all the accumulations which might collect in the street. They were built to run on a 400-volt grounded circuit, and to run in either direction with fixed brushes. Insanity was a mild term to designate the mental condition of one who made these proposals. The motor man was confined to his ordinary platform and the regulating devices there situated. A wire of one-fifth of an inch in diameter was extended over the track, and supplied at intervals of its length by a wire carried alongside the street where the strain upon the poles was least, and this main conductor was supplied at three or four central points by feeders from the central station. The current, moreover, was taken from this wire, not by a traveling carriage upon the wire, flexibly connected with the car, but by an arm reaching upward and pressing underneath the wire. This contact arm, which is now technically known as the trolley pole, was placed in the centre of the car and had a universal movement, resisting up and down displacement sufficiently to make a good contact with the wire, but at the same time free to follow all vertical deflections. In addition it had a lateral movement of considerable reach, offering little opposition to any side deflections by the wire itself.

Well, Richmond has passed into history. It has had its vicissitudes, it has had its victories as well. But it remains with all its crudities and with all the accidents which have marked its career, as the one great step in advance, whose features in the main, have been followed in almost all the recent electric railways. Machines have been made larger, they have been made mechanically and electrically more perfect. Changes of detail have been frequent, but most of the characteristic features there outlined mark today nearly every electrical railway which is either in operation, in process of construction, or under contract.

Taking our work alone and that of 1887 as a basis, in 1888 it was trebled. The work of 1888 was quintupled in 1889. As to what it will be in 1890 I will not hazard a guess. Its strongest opponents two years ago are now its best friends, and the enterprise, for which it was then difficult to get a dollar investment, to-day demands the best thought and the most active energies of two great corporations and a number of smaller ones. The contracts for electrical equipments involve larger amounts than almost any other electrical enterprise. The business done in this year will probably be not less than $6,000,000. Every street railway in the Unitrd States is watching with eager eyes the developments of the rival electrical interests. The friends of the cable system are on the defensive. The advocates of the electric system are reliant and aggressive. Its flexibility, the ease with which it is extended, its adaptability to various conditions of service, its freedom from long continued breakdown, the marvelous advances which have been made in perfecting its apparatus, all insure its supremacy.

As illustrating the progress of electric railways, I may state that there are about 130 towns or cities in the United States with one or more electric railways in operation, construction or under contract, and that these roads comprise about 1,500 miles of track, equipped with 1,700 motor cars, requiring 3,000 motors, of an aggregate capacity of 45.000 h. p., and steam and electrical generators of 25,000 h. p. The roads in operation are making about 100,000 miles per day, and within three months the mileage will be doubled.

We still hear occasional discordant cries about the possibility of breakdowns, the cost of operation, the danger of the current, or the unsightliness of overhead wires.

This latter question is rather æsthetical than practical, for as now erected the railway lines are among the most costly, and with care can, in view of the service rendered, be made very unobtrusive.

As regards danger, the electric car is the safest possible vehicle, because of the remarkable facility of control, and as to the objections to the overhead line on the score of danger which have been raised sometimes by the municipal authorities, and which have been cited by the telephone interests, they are, we may safely say, imaginary rather than real. Some two years and a half ago I settled upon 400 volts as a fairly satisfactory standard of potential for which the motor for street railway service should be built, allowing about 10 per cent. drop in the distribution on the line, making the potential in the station about 440 to 450 volts. In some cases, where dealing with heavy work on extended lines and small conductors we have raised the potential at the motors to about 450 volts, making no change whatever in the machine, and have run the central station at 480 to 500 volts. There are in the United States about 80 electric railways in operation. Almost every employé of the contracting companies and a great many employés of the railway companies themselves, including not only the linemen, and those whose business it is to work upon the electrical equipment, but also the conductors and drivers, have received shocks from these lines of greater or less duration, and under almost every possible condition. Yet in no instance which ever came under my observation, or of which we have any reliable record, has serious injury resulted from the shock of the current itself. When we consider that these shocks have occurred to persons of all ages and of all physical conditions, and for varying periods, the experience seems to be quite ample to warrant the assertion that as ordinarily constructed a constant potential circuit of 500 volts is not dangerous to human life, and we can dismiss that question.

Reviewing the work of the past two years, that which was promised for electricity has been in the main entirely fulfilled. It has proved itself capable of doing the most extraordinary work under the most unfavorable conditions. Grades of 12½ per cent., and more recently of 14 per cent., have been ascended with loaded cars. Grades three miles long, varying from four to eight per cent., have been ascended by a motor car pulling a tow car. It has done work where it would have been impossible to have done it by horses. It has enabled the running speed of cars to be increased even in crowded cities 50 per cent.; and on suburban routes speeds of 20 miles or more have been made. Experimental runs of 30 miles an hour on the ordinary street car with the narrow flange wheel have been attained; and on special experiments a speed of nearly 150 miles an hour has been made for a short distance. The electric car has shown that it can run faster on both up and down grades, that it can be gotten under way and stopped more quickly than a horse car; that with any given number of cars the mileage has been increased and the same time intervals made with a less number of cars. Many cars have made from 180 to 190 miles in one day. Horse space having been saved, the equipments occupy a third less space, and this fact, coupled with the ability to back when necessary and again quickly gain headway, has enabled an electric railway car in crowded and narrow streets to work its passage where a horse car would be at a dead standstill. Not only has the possibility of running down grade faster been established, but that possibility with a high degree of safety, because in the event of losing control of a car by the brakes, the instant reversal of the motor will bring the car to a standstill. This has frequently been the experience, and in one case which was recently reported to us, the inspector stated that a car was going nearly 35 miles an hour on the down grade before the driver attempted to reverse his machine; but when he did reverse it, he brought his car to a standstill with the loss of only one gear. Making due allowance for the possible excitement of the inspector, I think the car was moving at least 25 miles an hour when the reversal took place.

The riding of an electric car is unquestionably easier than on the majority of cable or horse cars, starting and stopping more easily, and being in a very large measure free from oscillation. It is scarcely necessary to say that the cars are cleaner, that they are brilliantly lighted, and that it would be possible even to heat them by electricity. The sanitary conditions are entirely altered, and the health and comfort of the people conserved by doing away with stables, with all all their unsavory characteristics and resultant injury to the value of adjacent real estate. Branch lines of every possible combination of grade, curve and ill-conditioned street, which has so often proved prohibitory to any other system of propulsion, have been operated by the electric system. Distances up to six miles or more away from a single station have been operated without difficulty, and large numbers of cars from one station. It can very properly be said that there have been many breakdowns; that machines have depreciated; that there have been exasperating troubles. True, these things have happened, and in case of defective workmanship and of careless inspection or management, they will happen again no matter what system of propulsion is adopted. The accidents which can happen to a motor come within a very limited category, and the liability of a motor to these accidents is being very rapidly reduced to a minimum, till it is becoming to-day the most perfect piece of machinery, capable of the longest continued use and a large amount of abuse. The very accidents which have happened, as simple as the causes are—and I may say here that nine-tenths of electrical troubles are due to mechanical defects—and the very makeshifts which have been temporarily resorted to to overcome the troubles and keep the lines in operation, are the best evidence of the flexibility of the system and the perfection to which it will arrive. No other machine in existence has, in so short a period of development, been brought to such adegree of perfection, is capable of such varied application, and can be so quickly and easily understood.

The cost of operation has proved entirely satisfactory, and my early claim has been substantiated. In a paper read before the American Institute of Electrical Engineers in August, 1888, and also in some earlier communications, I made an estimate as to the expense of operating a 30 car road, dividing these operating expenses under two heads: (1), those belonging to the central station; and (2), what may be called the road operating expenses, the sum of the two constituting the total cost of motive power. In making this estimate I used extra care, and while preserving its accuracy, made every reasonable allowance that I thought necessary. The conclusion at which I arrived in the estimate under the conditions there given, was that the total cost of motive per car mile should not exceed 4⅘ cents; and this included everything except executive and salary expenses, taxes and insurance, and other matter not connected with motive power. I also stated that this was about 40 per cent. of the cost of operating by horses for the same mileage, and under the same conditions. My estimate was then considered, altogether too liberal in favor of electricity. Without going into details, I may state that the most reliable possible records of roads, under every possible condition of service, bear out the claims that I then made as to the economical operation by electricity. I have the records of only a portion of the roads which we have equipped. Some roads see fit to make public these records. Others, and with a good show of reason, do not care to do so, because of the feeling that municipal bodies, in considering the granting of franchises, will not look at the increased cost of investment, but ignoring the manifold advantages to be gained by the introduction of electricity, for the public as well as for the company, are inclined to make unreasonable demands in the way of the reduction of fares, or require unnecessary and unprofitable extensions of lines. They forget that the reduction of one cent in a fare means a cut on 20 per cent. in the receipts of the company, and that a very remarkable saving of expenses must be made in order to meet this reduction of revenue, especially where there is an increased equipment on which interest must be earned. But suffice it to say that careful investigation will convince any candid man that the economic claim has been entirely supported, and the best elements of it is in the rapid adoption of this method of propulsion.

A few remarks may be in place relating to the interferences with other established interests which this new application of electricity has developed. Such conflicts, as electricity is applied to different industries, necessarily arise and result from the claims made by two or three enterprises to the same area of occupancy, whether of air or earth. There have been, long before electric railways became at all common, conflicts of a more or less limited nature between the electric lighting and telephone interests. In the early days of electric lighting, and more particularly in that branch known as constant potential distribution, an attempt was made to use the earth for one-half of the circuit, precisely as was done and has been done for years in telegraphy. Practical experience, however, demonstrated that this was a mistake where incandescent lights were concerned, and it is manifestly a mistake where arc lights and high potentials are used. The objections on the constant potential incandescent circuit were pertinent because of the liability of fire in the buildings where the ground circuit was used, and the element of personal danger very quickly put an end to an attempt to use a ground circuit for an arc light system. The same cautionary reasons applicable to these two classes of industries do not, however, apply to overhead electric railway systems. The electric railway circuit is purely an external circuit. Its derivations are through the cars which it supplies. It is led into no dwelling; its fixtures are not within the ordinary reach of any being. It is carried in the open air, in full view, in the most direct possible lines, and with only such supports as are necessary to make its construction safe, and to keep it in alignment. The whole construction of an overhead electrical system is materially simplified, and in my opinion made mechanically as well as electrically far safer by the adoption of a single wire, using the rails as a return circuit. The practical proof of the wisdom of this decision is the fact that about 90 per cent. of all the electric railways either in operation, construction, or under contract in the United States, use only the single wire underneath contact. It scarcely seems necessary at this stage to go into the defense of this system. Its simplicity, the lightness of construction, the symmetry of outline, the size and strength of the poles,

the fewness of the supports, the simplicity of all curve work, turnouts, crossings and sidings, and especially of all switch work and switch operations, are so manifest that elaboration of these features is unnecessary.

The use of the grounded circuit has unquestionably interfered with another and widespread application of the use of electricity, and that is the operation of telephones which likewise use the grounded circuit. So long as electric railways were in an experimental stage, running perhaps in suburban districts, out of the way of telephone circuits, little or no attention was paid by telephone companies to their existence. The strides which have been made in the past two years and a half, bringing the railway system into the very heart of towns and cities, and into the forefront as a commercial enterprise, and the rapid increase in the extent and use of the telephone system, have brought the two interests in direct conflict, which conflict is solely because of their common use of that great reservoir of electricity, if we choose so to term it, or rather that great common medium for conducting it which has been used alike by railways, telephones and telegraphs since these industries were started.

The claim of the telephone companies, in brief, is that by right of prior occupation and of their vested interests, no electric railway or other circuit shall so use the earth if interfering with their lines in any way. Their claim is far-reaching; it is of the broadest possible character, and, strictly interpreted, is an exclusive claim on the use of the earth for transmitting energy by electricity. That there is an interference with the telephone circuits by an electric railway circuit is undeniable, and the interference is one which is annoying. The character of the interference is twofold. Part of the trouble arises from induction, that sympathetic response in the telephone circuit to any changes in the electrical condition of the railway circuit, and part to leakage, caused by the diverting through the telephone system of a part of the current which has been discharged into the earth and is on its way back to the central station.

The relative amount of these two interferences has been variously stated. On the part of the telephone company it is admitted that conduction or leakage is a source of trouble. They also admit that the use of any metallic return circuit, it matters not what, whether it be an individual circuit for each telephone, or a common metallic return for all the telephones, will obviate this or most of it. Even this much is admitted by the telephone interests with a great deal of hesitation, despite its perfectly apparent truth. But they go further. They claim that this is not the principal cause of trouble, but that most of it is due to induction, and that if a return metallic circuit overhead were put up by the railway company—that is, if a double trolley system were used—then the telephone troubles would all cease. The various attempts they have made in the courts have been with a view to either compelling the railway companies to cease operations or to so change and erect their entire system as to abolish the use of the single trolley and erect in its place the double trolley system, or, on the other hand, to compel the electric railway company to pay for the necessary changes required in the telephone circuit to avoid the interference. No sooner was this issue presented than it was promptly met by the railway interests which I represent.

Now what are the facts? First, as I have stated, there is unquestionably an interference between the electric railway and the telephone services; but of the character of this interference it seems to me that no intelligent man who honestly makes an investigation, seeking truth, and truth only, and unbiased by the commercial interests which have retained him, can have any reasonable doubt. The assertions made by the telephone interests leave little room for exaggeration on their part. Not only has the character of the interference been misrepresented, but the costs of any changes made necessary on the part of the telephone company to avoid trouble, or on the part of the railway company to change over its system, have been grossly misstated.

As a matter of fact, the trouble from induction is of the very slightest character, and that must be patent to any one who is familiar with this particular electrical action. Generally the trolley wire is situated in the middle of the street, anywhere from 20 to 30 or 40 feet away from the telephone lines. It rarely runs parallel to them except for a comparatively short distance, possibly two, or even three miles, but more often less. The current used upon this wire is not of that character which distinguishes some of the arc light circuits, but is of more or less even flow, and the abrupt and large changes due to change of load on the motor are comparatively infrequent. There is a very small change due to the variation of resistance of the armature of the motor, because of the different relative positions of the commutator blocks under the brushes, and there is likewise a variation due to the slight but rapid changes of counter electromotive force set up by the motor when running. But although these changes can be detected inductively, provided the conditions are favorable—for instance, if both the telephone and railway circuits were wound around a common bar of iron—the character of the disturbance is not so serious as to preclude conversation. But the trouble which does really become pronounced is that which is due to the actual difference of potential which exists on different parts of the track circuit—in other words, at the terminals of the grounded telephone circuits. There is discharged into the earth, as I have pointed out, a slightly varying current. It may be at some point considerably removed from the station and in close proximity to the ground terminal of a telephone whose exchange is likewise grounded at another point much nearer, electrically, to the station than the point of discharge. The current reaching the rail has to travel back to the station, partly by the rails and partly by the earth. Both offer more or less resistance, and there is an actual difference of potential between the point of discharge and the station, rising at times to as much as 20 or 30 volts; but it is, of course, a variable potential, and the current which flows over that path is one which varies in its character. Having discharged the current in the earth, there is absolutely no limit to its diffusion. We desire, of course, that it should return by the rails, but no boundary can be placed upon it. A part of it goes through the rails, but some portions will go through the earth, through water ways, mineral veins, gas and water connections, electric light tubes, telephone circuits, rivers and canals, and, in fact, over any and all paths which offer it opportunity to return to the source from which it originated. The shortest geographical line between two points may be a thousand feet. The paths of the current between those two points may be anything from a thousand feet to fifty thousand or more. But precisely as the rail current is this disseminated or diffused in its return paths, so also is the telephone current. True, it is only a current of small capacity, so small as to interfere with no other enterprise or translating device except others of like character, but its diffusion is of precisely the same character and over the same territory and through the same classes of conductors as that of the rail current. Could the telephone current be limited in its path, and the claim of the telephone company be narrowed down to a specific section of earth, then, possibly, there might be some basis for a claim to the use of that section; but such a restriction is, of course, manifestly impossible. Hence, any claim the telephone interest makes to the earth must be vague; it must be all-reaching: it must be exclusive. It would seem that it has no more legal right to make a claim which prohibits a railway in the town in which the telephone circuits are operated from using the earth, than it has to make a claim that a railway in any other city with which the telephone may be remotely connected, shall be prohibited likewise from using the earth in that particular city, although it may be a hundred miles off. It is a well-known fact among electricians, and probably no better known than among the telephone people themselves, that, perfectly independent of railway enterprises, a far better service can be rendered the patrons of the telephone where a complete metallic circuit is used, and the use of the earth abolished. The telephone is the most jealous detector possible of all disturbances of electrical condition on the circuit which includes it. Its very function as a transmitter of speech depends upon this marvelous delicacy. As now operated in the majority of telephone exchanges, it is subject to continual interference, not only from the railway circuit but from every electric light, power or telegraph with which it is brought into proximity. It is subject to interference from atmospheric changes and discharges. The telephone circuits themselves interfere with each other. Cross talk and false signaling are common. Almost all these troubles can be avoided, and the telephone service made far more perfect by using either the individual metallic return with the switchboard properly constructed for it, or the individual return, the return wires coming to a common terminus, which would make absolutely no change in the telephonic switchboard; or what has become known as the McClure device, the use of an artificial metallic ground or common metallic return—that is, by breaking the ground connections of the individual telephones and connecting them all to one common copper return of a resistance which shall be low compared with the resistance of the instruments themselves. The lower the resistance of this common return the less any interference of the telephones with each other. The cost of this latter method is a bagatelle. It should be put up by the telephone companies for the sake of their patrons, independent of whatever other electrical enterprise they may be brought in contact with. Wherever intelligently put up the relief from outside interference has been almost absolute, and the testimony of parties who made complaint when telephone companies first sought to obtain an injunction against the railways is now emphatic as to the relief which has been obtained by this change in the method of running the telephone circuits. It is unquestionable that the telephone company is waging the warfare from the standpoint of economy, pleading the rights of vested interests, notwithstanding every telephone expert knows the great advantage to be gained from a metallic circuit, and notwithstanding the fact that sundry papers read at the telephone conventions not only admit that the metallic circuit is best, but give testimony from the exchange superintendents that wherever their patrons once use the metallic circuit and long distance telephone, they are never satisfied thereafter to use the grounded circuit. It is likewise suggestive that the Bell Telephone Company to-day advertises no less than about 150 local stations in New York City equipped with the long-distance telephone and the metallic circuit. Since there is not an electric railway in the city of New York, their action in this locality could not have been dictated by interference from that interest.

The position, from a legal standpoint, seems to be something as follows: As between telephone and electric light and power companies there may be a question concerning respective rights, because the electric light and telephone companies may both occupy the highway as of equal dignity. But even in such a case neither one of the interests can have just right to an injunction, because the proper way of redress is a suit at law to determine the amount of damages for which the one party is liable on account of a violation of the other's rights, permanent injunction being granted, I believe, only where the troubles are irremediable, or where the damage cannot be readily computed. Wherever the telephone, however, seeks to trammel electric railways in their free use of the public highways, and especially where they have been granted the right of such use, an entirely different question is presented. The public highway was originally and primarily dedicated to public travel whether by foot, by horse or by vehicle, and for no other purpose. It was contended some years ago that street railways ought not to be allowed upon highways because they had tracks; but wherever courts have been called upon to make a decision, it has been held that street railways were but an improvement upon the old methods of travel. It was even at one time questioned whether there might not be a distinction between the rights of a street railway, where the public owned the fee, and those in which the title was in private individuals, but even this distinction was not allowed. When electric railways were developed, an attempt was made to claim that they were a perversion of the highway; but it was then held that electric railways were an improvement only upon street railways propelled by horses or other motive power, and should occupy the highways with the same rights as were enjoyed by the street railways using the other motive power before electric propulsion was resorted to.

Since both the telephone and the railway companies occupy public streets by public license, it is of course necessary to examine into the source of their respective titles and the character of their occupancy, because otherwise it would be impossible to understand what are their respective rights. The electric railway has proven a great advance upon any method of street car propulsion hitherto known. It has been shown to be economical, safe and advantageous as a method of public travel. It certainly cannot be said to be objectionable *per se*. It interferes less with the travelers upon the highway than many other methods of propulsion, and its very extended adoption shows us that it has been sanctioned by public authorities as a safe and proper method of travel. The single trolley system being used by nine-tenths of the street railways in the United States using electric motive power, as against all other methods, certainly shows that practical experience is in favor of that particular method. As an improvement upon the method of propulsion it would seem that an electric street railway uses a public highway, occupies the same and enjoys the right of travel thereon, as of equal dignity with any or all other persons or vehicles upon that highway, and that this right of enjoyment is within the original purpose for which the highways were opened. On the other hand, it is pertinent to inquire what right or title a telephone company has in the street. By virtue of the original dedication of the highway they have no rights except that of toleration. Telephone and telegraphs are identical incontemplation of law and have been held to be an additioual burden upon highways. In almost every case where this question has come up in the matter of telegraphs, such has been the decision. The statutes under which telephone or telegraph lines are permitted to be erected on highways provide that while they may be so ecected, the poles and wires shall not interfere with public travel upon the highways. Since this is true, the telephone companies are upon a public road not by virtue of right, but of toleration; not as the equals of the street railway, but subordinate to it. They occupy a secondary position, and this being the case, where conflict arises between the two, it would seem that the telephone interest must eventually yield, for its claim against any competitive enterprise is nothing less than a claim to the exclusive right of the earth, not to some section of it, because there are no limits to which the telephone wires may not reach, no boundaries to the portions of the earth which form a part of their circuits. Certainly no statute gives an exclusive privilege to a telegraph or a telephone company; and any claim for such an exclusive right, to be substantiated, must show an express or implied grant from some source, and the boundary as well as the source of that title. Not only this, but it must show that the title is exclusive. In view of the fact that the telegraph companies had used ground circuits for 30 years or more before the telephone was discovered, and that patents were refused for such use, it will be somewhat difficult for the telephone company to show the source of its title; and it is manifestly impossible to show the limits of the territory from which any other enterprise must be excluded, so that it will in no way interfere with the operation of the telephone system, for the telephone circuits being attached to the gas and water systems of the community in which it is located, the ramifications of such systems and of all the subterranean electric conductors of the earth in contact with these metallic conductors are unknown to science. How other electric currents entering the earth may do so without invading the charmed area of the telephone and disturbing its grounded wires no man can say, much less can the telephone people themselves. The boundaries, then, of their claim being so vague, it would seem that their claim itself must necessarily fail.

Within the past two years there have been, I believe, eight attempts made by the telephone interests to get an injunction. The first was in Akron, O., in the latter part of 1888, where the Central Union Telephone Company, of Chicago, attempted to restrain one of the Sprague roads by injunction. This was denied. The next suit was against the Harrisburg road and the Sprague Company by the Penn Telephone Company. A number of common stockholders, I believe, were interested in both companies, and although the attorneys of the railway companies were fully prepared and desirous of seeing the case brought to trial, the case was abandoned and compromised for the very sensible reason that it would cost less on both sides to compromise than to carry it to the higher courts. The next attempt on the part of the telephone interests was in the application for an injunction against one of our roads at Chattanooga, Tenn. This injunction was denied. Then came a conflict in Salt Lake City, where many of the people were so interested that they said as between the telephone and electric railway interests, if the decision was against the railway company they would abolish the use of the telephone. Such heroic measures apparently were unnecessary, for the injunction was twice denied. Then application for an injunction was made in Cincinnati—and this will probably become a cause of célebré for an injunction, on what ground I do not yet know—was granted, and the case will be carried to the higher courts.

In Eau Claire, Wisconsin, an attack was made on the railway interests under cover of a State law which the telephone companies had quietly gotten passed requiring a return insulated conductor for any circuit carrying electric energy. The injunction was there denied, for the telephone company had somewhat overreached itself, and found itself quite as much in the mud as the railway company might be in the mire so far as the law was concerned, because they were themselves the carriers of electric energy and were using grounded circuits, and consequently had no standing before the court. The last case with which we have been directly concerned is one at St. Joseph, which has not yet been tried. In Albany, where another electric railway company is operating, the telephone interest has succeeded in getting a temporary injunction. I believe this case, in which my own company is not particularly interested, except sympathetically, has been recently reheard and a decision on the merits is now pending.

With the records thus given it would seem that the electric railway companies have little to fear from the attacks made upon them by the Bell Telephone Company. They are well within their right, and that being so, their position must sooner or later be established beyond all peradventure. The cases which I have enumerated are not the only cases in which there have been interferences between the electric railway and the telephone; but in almost all others, both the railway and telephone companies have recognized each other's moral, if not legal, rights. Often the same stockholders have been in both companies, and a sensible compromise had been effected, in which the telephone company has sometimes changed the route of its circuits, or put up a common return, or the companies have used each other's poles, and a just division of expense has been settled upon. This would seem to me to be the better plan wherever conflicting interests arise, and is one which I would recommend in all cases where the telephone companies are willing to recognize the justice of the legal position of the railway company instead of attempting, as they have in the cases mentioned, to deny that right. A just conpromise, but no surrender, should be the motto of the railway company.

So much for street car practice, and looking forward we naturally ask what will be the near future of the application of this remarkable agent? Already we have gone from one car units to trains of 2, 3 and even 4 cars in the street, and 4 cars have been operated from a single station. The next step will be the operation of some of the cable roads, then systems like the Underground Railway of London, the Elevated railways of New York, the Brooklyn Bridge system, and then suburban lines will be operated. But is this the limit?

I have been frequently asked whether, in my opinion, electricity will ever be used on trunk lines for through passenger or freight traffic? My answer is: Probably not, according to present notions of trunk line transportation, and not by present methods of train dispatching. But in these qualifications I admit my hope and expectation of rapid transit under certain conditions. Let us for a moment consider a few facts.

Railway managers are constantly meeting with a demand for more rapid and luxurious methods of transit, and every effort which executive ability and financial expenditure within reason can devise is made to meet this demand. I think I can safely say that as steam railways are operated, a maximum speed of ninety miles per hour, and a running speed of sixty to seventy is all that can be hoped for in steam railway travel under the best conditions which can be provided. The limitations are too many. The maximum speed made by a locomotive to-day is but little more than was made twenty years ago. True, engines are larger and more powerful, but the increased weight of trains has made this necessary. To get pulling power there is a limit to the size of the drivers, and whatever their size there is a limit to the economical rate of piston speed and to the number of revolutions per minute. As the size of the driver increases the centre of gravity of the engine is raised. As the steam demands become greater the difficulty of taking water and of firing grows more pronounced. Even now it requires the best work of a fireman, when his engine is pulling heavy load, to prevent the engine dying on the road, or at least falling far short of its duty. The increase of running speed has been obtained principally by cutting down-grades, straightening curves, filling up ravines, replacing wooden structures by permanent way of iron or stone, the use of heavier rails, safer switches, improved methods of signaling, the interlocking switch and signal system, road crossing gates, the abolishing of grade crossings; in short, by improvements in detail and management which permit a higher safe speed over a more extended section of road because of greater intrinsic safety, and of the greater degree of confidence inspired in engine-driver, rather than by marked advance in the speed capacity, which should not be confounded with the pulling capacity of the engine *per se*.

With respect to electric motors, the question is not now if a motor of sufficient capacity be built, or efficiently and positively controlled, but rather how can the electricity be produced and supplied to the motor and at what potential can we work. We all hope to see the time when electricity can be produced economically from coal without the inter-

vention of engines or dynamos; and it may be that something akin to the present steam practice will be common; but I think that even then it will be quite likely that a central method of distribution will be the more advantageous. On the other hand there are those who hope to see the storage battery so reduced in weight and improved in other particulars as to warrant its use in a large way in locomotives. For myself, I prefer to consider the possibilities of another method, the amplification and development to its full capacity of the present street railway practice, and for that purpose I will briefly consider a suppositious case, namely an express between New York, or rather Jersey City, and Philadelphia. But before considering this problem, let me point out a feature or two about steam roads. When first laid through a new country they usually consist of a single track, which must do the manifold duty of providing for through and local freight, and local and express passenger traffic in both directions, with what success those who are called upon to travel in new countries are well acquainted. The route of such a road is determined mainly with the idea of getting from one place to another by a more or less direct route, but especially one which shall not require too costly construction. Once determined, new towns spring up along the line of the road. and old towns grow until the demand of traffic make a double track necessary. As civilization grows apace, the freight traffic demands a track by itself, and four tracks constitute the equipment. So, following the development of the road, we will find that in time the express and local passenger trains may require individual tracks, and a six-track road will be a necessity. But it must be borne in mind that the express is not intended to cater to local travel, but its route is subordinated, both in the matter of curves, grades and crossings to the requirements of the early construction. The highest demands of such a service would require that, indepe dently of the local travel, a through express track should be constructed by the most direct route possible between the princi al localities, and every effort made to reduce the curvature and grades as much as possible. No matter how much it costs to build such a road, when the traffic is sufficiently large, it will pay to do it.

Suppose such a road to be an electrical one, and the method of supply to be from one or more central stations, the current being taken by a universally flexible underneath con act from a rod carried above the car, and the return circuit made by means of the rails. This method, using, of course, a wire instead of a rod, having been almost universally adopted wherever street cars are propelled by electricity, its characteristics are well known. What the structure of the roadbed would be need not here concern us. We might use the standard T rail and roadbed, avoiding as much as possible curves, grades and grade cro sings, and the overhead road can be used simply for supplying the current; or some form of a double or single track road slightly raised above the ordinary level, and with the upper rod forming a steadying and centering chord as well as a current supplyer may be used. These are mechanical questions with which we need not concern ourselves at present. What does con cern us, however, as electrical engineers, is whether the cost of copper, the potential required, the losses on the line and the number of stations are such as would be prohibitory.

As regards the potential, other things being satisfactory, whatever pressure is demanded in the interest of economical and effective service will be used, and means will be found, consisting mainly in cars of construction, which will make its use for the purposes, and, as intended, safe and proper. We have, in these matters, to face the same questions that we have in the matter of steam pressure, or of railway speed. To accomplish the larger engine ring feats necessary to meet the demands of economy and commerce, we will be governed more by belief in our power to fully subordinate a good servant to our will than by our fears of its vagarics when allowed to become a master.

From 8 A. M. to 9 P. M., a period of 13 hours, 21 regular trains leave the Jersey City station of the Pennsylvania road to run through to Philadelphia. Twelve of these make but one or two stops. The balance make more or less stops according to the running schedule. In addition to these there are a number of local trains serving way stations. Taking the through trains only, and allowing an average of say five cars to a train, there are in the 13 hours about 105 through cars dispatched from Jersey City, or at the rate of one car every 7½ minutes, and of the through cars not making over one or two stops there would be one every 13 minutes. We will suppose an additional express track has been built, leaving the distance about what it is now, say 90 miles, but that the grades have been eased and the worst curves rectified. For the practical purposes of this paper I will consider that the road is level, that the cars are to be dispatched in two-car unit on a perfect block system, and to run through to Philadelphia with not more than one stop, at fixed intervals, and at a high average rate of speed, say 60 miles per hour. In the systems that I would propose—practically that with which I experimented some years ago—slight grades would make little difference in the general result, especially if the grade percentage, expressed as a whole number, does not exceed the quotient of the traction in pounds per ton divided by 20; because when $c = \frac{t}{20}$, where t equals traction in pounds per net ton, and c equals grade percentage expressed as a whole number, the work of traction and of lifting are equal. For example, suppose $t = 10$ pounds and $c = \frac{1}{2}$ per cent., and that we had on a double track one unit coming down the grade and the other ascending it, both at the same speed. Then gravity would be supplying just enough power to propel the car on the down grade at a fixed speed, and enough power to suppiy the lifting and traction work of the other car would have to be supplied, which would be just the amount required to propel both cars on a dead level.

Suppose the grade to exceed the ratio expressed above, then the car on the down grade would have an excess of falling energy, and this would be used in accelerating the speed of the car, or on the brakes, or it could be used by a process of reconversion for the purpose of supplying at short range part of the extra energy required by the ascending train. Just how this can be done is pretty fairly understood by electricians, but I will touch upon it again, because it is a feature of vital importance in determining the matter of motor control in a large system such as we are now considering, and because it illustrates one of the most beautiful features of this method of converting energy. No matter whether a machine be used for a motor or a dynamo, whether to convert mechanical energy into electricity or the reverse, the armature develops an electric pressure or potential which is dependent upon its speed and the effective strength of the magnetic field in which it is used. If this field is in shunt relation to the armature and in connection with the track circuit, we have by any of the well known methods a means for independently varying the strength of that field. When such a machine is geared to a car, it can either drive the car, acting as a motor, or be driven by it as a dynamo, and in connection with any other similarly connected motor, or the central station generators, will form an electrical couple, either of which may be driven by, or drive, the apparatus to which it is connected. If the couple thus established is between the motor and the central station dynamo, we have at one end a machine driven by a constant speed engine and generating an approximately constant electromotive force, and at the other end a machine of greatly varying speed, and with facility for increasing or diminishing the electromotive force which it generates. The result is an electrical differential which will establish a current between the two in one direction or the other, according as the pressure developed by the motor is lower or greater than that developed at the generating station. If the pressures are equal no current will flow between them. If the couple consists of two motors thus connected, then we have two apparatus, each of which is generating a variable electromotive force, and there will be a current between these or not according to their relative electrical pressures. A large system is tied together in the most intimate manner possible. The tracks are cross-connected, the overhead conductors cross-connected, and we would have, in effect, what would correspond to two large planes, between which is moved at varying speeds a number of independent units these two planes being kept at a fairly constant potential by means of the generating station. All motors starting, running on a level, or ascending a grade, would be requiring current. All motors running on a down grade with just that velocity which the force of gravity would give them would require no current; and motors running on down grades of greater percentage than is required to give them power for traction, or motors slowing down, would be generating currents to aid in the general supply. No other system of distribution can by any possibility have this very remarkable interchange of energy. When running at a particular speed a slight movement of a regulating handle would make the motor receive from or give to the line currents in any desired quantity. The braking power of a motor thus acting as a generator is very powerful and the most perfect imaginable, because, unlike the ordinary methods, the brake does not operate if the wheels stand still, the very essential of the braking operation requiring the wheels to turn. It is a well-known fact that the most effective brake work is when the wheels do not skid upon the track, but when they are turning under the pressure of the brake; and contrary to the ordinary braking practice, the energy of the electric train instead of being thrown away, in the form of heat and using up the wheels and brakeshoes, can be made useful in the propulsion of other trains. I have tried this method of braking with such a degree of refinement that a heavily loaded car would creep on a down grade at a pace so slow that an egg could be put under the wheels and cracked and removed before the wheel would pass over it.

Having thus touched upon the characteristics such as I would propose for a railway system of this character, let us resume the consideration of the proposed line between New York and Philadelphia, and try to form some idea of the electrical pressure which would be required, the service which could be demanded, the number of cars which could be handled, the speeds which could be maintained, and the number of stations which would be required to operate the stations. We will assume, for the purpose of this investigation, an overhead conductor in the form of a solid rod one inch in diameter over each track, or, if you please, a smaller rod over each track, and a main conductor making up on equal weight, and a track of equivalent capacity. I take this arbitrary size because it is convenient for the purposes of our calculations and because it falls well within the limit of expenditure which such a system would warrant. For instance, the American Bell Telephone Company has a line of long distance telephone wires running from New York to Boston, a distance of about 300 miles, nearly three and a half times the distance which we are considering. On these poles are about seventy wires each of No. 12 copper. The aggregate area of these conductors is over 800,000 circular mils, and the total weight of copper on this line, which is used simply for telephonic purposes, is about 40 per cent. more than the weight of two copper rods an inch in diameter running from New York to Philadelphia. If the investment is a reasonable one in the telephone system, cannot we certainly consider it a reasonable one in that larger field of the transmission of power of which we are now speaking.

As I have stated, of the number of trains which in 13 hours leave Jersey City for Philadelphia 12 usually make only one or two stops Allowing 60 cars, this would be about one car every 13 minutes. This interval of 13 minutes is nearly as short as would be desirable between cars running at an average speed of a mile a minute, no matter how perfect the block system, and it would be necessary to run these cars in double car units. We will assume for our purposes the size of a car such as is used on the elevated road in New York or the Brooklyn Bridge, which would, with motor and passengers, weigh from 20 to 25 tons, or a total of say 50 tons for our unit. The formula to determine the size of conductor for a single transmission of car is:

$$cm = \frac{15{,}666\ n\ l}{E\ v\ \varphi}$$

where n = the number of horse-power, l = the distance in feet, E the potential at the motor, v the fall in potential and φ the commercial efficiency of the motor. If we assume the station situated in the middle of a line, that is, at the best point, and the work divided equally at the middle section on each side, then l being the length of line, we have the formula:

$$cm = \frac{15{,}666\ n\ L}{4\ E\ v\ \varphi}$$

This will be practically the same if the work is distributed over the entire line.

If more than one station is used, then the formula will become

$$cm = \frac{15{,}666\ n\ L}{4\ E\ v\ \varphi\ S^2}$$

that is, the size of the conductor would vary inversely as the square of the number of stations, if properly distributed. v may be expressed as a fraction of E, and for practical purposes we will let $v = \frac{1}{5}$ of E, and φ such that

$$\frac{15{,}666}{\varphi} = 16{,}800,$$

that is, φ = about 93 per cent. Then we have

$$cm = \frac{37{,}800\ n\ L}{E^2\ S^2}$$

which may be expressed thus, that the size of the wire varies inversely as the square of the product of the number of stations and the electromotive force.

We may also note that with any fixed size of conductor the electromotive force and the number of stations vary inversely—a somewhat important fact to remember.

We have another formula, one for the power required by a moving car, which is

$$hp = \frac{4}{75} w\ m \left(c + \frac{t}{20}\right)$$

where w = the weight in net tons; m, the miles per hour; c, the percentage of grade expressed as a whole number, and t, the traction in pounds per net ton.

As I have stated, we will assume in this formula that c equals zero, a consideration in which I am justified in express service on a road of the character I have outlined, with the relation of grades and traction given, and with the method of braking I have described. Our formula would then become, using 10 lbs. per ton as our average traction,

$$hp = \frac{2}{75} w\ m$$

which, substituted for n in the distribution formula, gives us

$$cm = \frac{1008\ w\ m\ L}{E^2\ S^2}$$

or substituting for L, 5,280 d, d being the number of miles between stations,

$$cm = \frac{5{,}322{,}240\ w\ m\ L}{E^2\ S^3}$$

we have assumed for our conductors two rods an inch in diameter, and that the rail has the same resistance. Hence, substituting for c. m. its value, 2,000,000 we have

$$E = \frac{2.66112\ w\ m\ d}{S^2}$$

or

$$E = \frac{1.631}{S}\sqrt{w\ m\ d}$$

It will be noted that m, w, and d, that is, number of miles per hour, weight handled, and distance over which operated, are all affected in the same way. Hence with any value of E and S we can vary the relative values of w, m, and d so long as we do not disturb the product. That is, we can halve the number of miles and double the speed, or double the distance and halve the running speed, keeping the weight hauled the same, and so on. For w, the total weight, we can substitute the weight of each unit, c, and the number of units, b, thus making the formula

$$E = \frac{1.631}{S}\sqrt{m\ b\ c\ d}$$

For the line proposed, d=90, and we have

$$E = \frac{15.56}{S}\sqrt{m\ b\ c}$$

Taking our unit of two cars at 50 tons, the time intervals between them at ten minutes, and 60 miles per hour as the mean speed, we have on the whole system eighteen active units of two cars each, and $m\ b\ c$ = 54,000, which substituted in our formula gives

$$E = \frac{3{,}615}{S}$$

which means that with one station in the middle the potential at the most or farthest from the station would be 3,616 volts, and near the station one-ninth higher. Can we handle it? Yes, in time, but perhaps not yet. Nor is there any necessity for doing so; for if we increase the number of stations and go to a three-wire, instead of a two-wire system, making the track the balance of circuit, we would have the motor potential as expressed by the following table.

Stations		Motor Potential	
Number.	Miles apart.	2-wire.	3-wire.
1	..	3516	1808
2	45	1808	904
3	30	1205	603
4	22½	904	452

which last brings us down to ordinary street car practice, which is only the beginning of what will be done in the effective handling of potentials.

So, after all, it does not seem such a serious electrical problem, and certainly not one to shrink from.

We can in another way illustrate the influence of the position and number of stations and the potential used. Suppose we had a station at Jersey City to supply the entire line at a certain potential over a conductor of the required size. If the station be moved to the centre, the weight of copper necessary is only one quarter. Use two stations properly spaced and the weight is quartered again. Double the potential and the weight is further quartered. Now use the three-wire system and the weight is again quartered. So that by these very simple processes the original weight has been reduced 1-256th of the original.

I don't think I need to point out further the use of a proper determination of electrical values in a problem of this character.

We see then that the suppositious case is well within the range of possibilities. A 60-mile express service every ten minutes instead of a 40 to 45 mile service every hour would revolutionize travel. Of the comforts of such a system I need not speak. That it will in the not very distant future be a fact, I know you all agree with me in hoping.

When Mr. Sprague closed his address, the convention saluted him with a hearty round of applause.

Judge ARMSTRONG: I do not mean to undertake to discuss the paper. I am interested in electric lights. We have made a contract with a street railroad company in our city, in which I am also interested, to supply it with power. I did not want to stay over to-day, but my general manager insisted that I should. I did stay, and I have been amply rewarded for it. I want personally to thank Mr. Sprague for one of the most intensely interesting papers to which I ever listened. The figures that he has given us, the explanations that he has made, and the statements throughout his address have been to me of the most intense interest. I was pleased with the legal position he took. As a lawyer, I must commend him as a very good lawyer. (Laughter and applause.) Some of the matters he has stated were novel to me in the statement of them, but he stated such general principles that I had to say I knew it all the time, but didn't think of it. (Laughter and applause.) You know it is a very wise man that will tell you things that you knew all the while, but hadn't hold of the ends of it. I think I will have to send him a sort of retainer, because he has given me, outside of electric light, outside of any such connection as this, an idea relative to some legal troubles we have with our street railroad; so I am particularly obliged to him on that account. I owe him a further obligation for what he has given us as to the increase in the use of electric power, the possibilities that he has opened to us by pushing the door a little aside. Personally I am obliged to him, and, as an association, we ought to be obliged to him, as central station men who are creating this wonderful power, who have it for sale, who wish to send it out; and I am sure the rest of the members of the association want to say to Mr. Sprague that we appreciate very greatly this wonderfully interesting and wonderfully able paper. (Applause).

MR. SPRAGUE: I do not know that my modesty will allow me to thank you for the compliment to my legal ability. (Applause.) I think the amount of your retainer ought to be turned over to Mr. John S. Wise, the counsel of our company, whose pupil I have been in that matter. It is more a statement of his position than of mine in several suits. I asked him to explain the matter to me, and on his doing so I tried to put it in my own phraseology as well as I could. You have touched upon a subject which is an important one, certainly to those who are managers of electric light stations, when they are called upon to supply the power for electric railways, that I would have presented to you, but had I done so it would have made the paper too long. The investigation we have made refers particularly to the amount of power which has been used in central stations.

The amount of power used, of course, depends upon the amount of traffic, the number of cars run, the schedule,

the intervals between the cars, the grades—in fact, there are a great many questions which determine it. But we have very recently had an investigation made on five roads, embracing every possible condition, and in a short time those will be published in detail, and the results, which will be interesting to you as central station operators, is the amount of operating power, the maximum per car, the minimum of current used. All these figures will be very exact, and they will be useful in determining the contracts which are sometimes entered into between electric railway companies and electric lighting associations.

The cost of operation of railways is very much less than we have claimed. Whenever we have asked the railway companies to give us this cost, they reply: "Well, when we were in the early stages of this business it was necessary to bring us to a satisfactory condition of mind to sign a contract—it was different. We find there are a great many elements of economy, now we have gotten there, and we would be glad if you would keep that element of economy out of sight, and do not publish it broadcast, because we do not want some legislative body to come down on us and say, 'Reduce your fares to four cents, or sell seven or eight tickets for twenty cents.'" So we have had, commercially speaking, to accede to that request. There will be gradually, in many of ourcities, an amalgamation of the electric light and railway interests. It seems to me that is the natural outcome, and I know that oftentimes the same stockholders are interested in both the electric light and railway companies. I am going to have, very soon, in a little town in South Carolina, what I think is the most complete electrical station in the United States. Some associates and myself, being convinced that not only the electric light but the electric railway business was a good thing, from the experience we have had with it in the past two years, got hold of an electric lighting company that was earning a very reasonable dividend on its cost. They had an electric railway franchise which was exclusive for thirty years, and which had been granted both by municipal and legislative action. They also had the general railroad privileges of condemning public and private property. Their rights being exclusive not only in the two towns, but for the vicinity, for thirty years, and there being no railroad there, and there being established an electric light interest there, and there being no gas company, we thought the opportunity was an excellent one to carry out that idea which is always in the minds of electrical people, namely the consolidating of electrical interests. We not only consolidate the electric part of it, but we consolidate the elements of management and personnel. We have different systems, the arc light system, the incandescent system, the power circuit and the railway circuit, all in the same building and under the same roof of the car sheds, and with all respect to the telephone interest, I think pretty soon we will have the telephone circuit; we are going to run telephone wires on the same poles with the others. We are going to demonstrate that it is quite possible to run a telephone circuit and an electric railway pole line not only in conjunction with it, but in conjunction with electric lights and incandescent lamps. We hope this enterprise will be profitable, and that there may be a great many other places in which the same thing can be done.

Mr. DECAMP: I would like to ask the gentleman, when he gets that arrangement consummated, whether he is going to put that forth to the world? If he is, I would simply say don't. I would also like to know, when he gets through, who is going to own that town?

Mr. SPRAGUE: As between yourself and me, Mr. De Camp, I hope we will. So far as the cost is concerned, we will make that more or less public, I think. We shall also put forth the fact that everything is being run under one management. We shall not claim that the economy is due entirely to railway operation, but we shall claim that simply because the same boilers are supplying energy for all the purposes, that is the reason for the good results.

Professor EATON, of Liberty College: I would like to ask Mr. Sprague if he has any objection to stating what his Principal reasons are for his conclusion that the storage battery system will not successfully compete with the overhead or direct wire system?

Mr. SPRAGUE: It is this. The simple reason is that you cannot three times convert energy, at the same economy that you can once. That is the first reason. Secondly, because you cannot carry a dead load of two tons around, unnecessarily, without energy; you cannot carry it around anyway necessarily or otherwise, without energy. You have got to carry your storage battery and you cannot get rid of that useless load. It weighs nearly two tons. It weighs as much as thirty-five or forty passengers. It weighs more than your motor equipment; it weighs more than your car body considered by itself; it weighs more than your iron trucks considered by themselves. We have to carry our motors around, we have to carry the trucks, the passengers, and the car bodies; but to carry our storage battery is another thing. There are no storage battery equipments in existence, furthermore, whose storage capacity will permit of more than 25 or 30 h. p. being taken out of them. If you limit the weight of size of your battery, you reduce its capacity. On grades of eight per cent., and that is about the maximum which the adhesion of the rail will permit, you find a great difficulty; you will use about thirty horse power of mechanical energy, and the motor has got to develop that. There is no storage battery that you can put on a 16-foot grade to-day out of which you can take that power for thirty minutes at a time; the capacity is not there. But when you get the overhead line or the underground conductor, provided it is connected with a big engine and a lot of dynamos at the other end, you can demand from that station all your motor can carry. There is no storage battery in existence in the United States, which any storage battery company dare recommend, that you can put upon a six per cent. grade and operate it, or that you could run 160, 170 or 180 miles a day. The maximum work of a storage battery per car per day, is about 80 or possibly 90 miles, and there are very few cars doing that. There are no storage battery cars in the United States, that I am aware of, that are working 18, 19 or 20 hours a day, as is the case with the direct system of supply cars.

I hope, as cordially as any other man, that the storage battery is going to be a success; but there is no question but that its limitations are pretty clearly fixed, and that it can never compete with direct sources of supply. There is no limit to the capacity of the motor or the amount of current you can use from a direct source of supply. There is certainly a well-defined narrow limit in the case of the storage battery. I say that with all friendliness to the storage battery, because I am interested financially in one—or, rather, I should say, one is financially interested in me.

Mr. C. C. Haskins, of Chicago, then addressed the convention on the subject of Prodigality in Economy.

The PRESIDENT: Before having a general discussion of this topic we will hear from Mr. Harber on the subject of line insulation.

Mr. Charles A. Harber, of Kansas City, then addressed the convention as follows:

LINE INSULATION FROM THE STANDPOINT OF PRACTICAL EXPERIENCE:

The question of the day for electrical industries is insulation. Believing that any information bearing thereon and derived from experience may be valuable, I present a brief record of measurements to determine the relative resistance of several forms of insulation:

In what follows I lay before you the results of daily measurements made in the interests of the company whose central stations I have in charge; but I assume to draw no conclusions save the urgent need of constant vigilance. It being my object to draw out rather than exhaust discussion, I leave to others the matters of proper construction, inspection etc., all of which are equally important.

During the past 24 months I have personally tested the insulation of our conduits. The instrument I used is the Electrical Supply Company's standard testing set, composed of silver battery of 24 cells, and combination of Wheatstone's bridges with galvanometer and variable resistance. I have measures from $\frac{1}{100}$ to 1,111,000 ohms. Measurements are taken shortly before closing circuits, first taking the precaution, however, to ascertain if the circuits to be tested are crossed by live wires; which, if not producing sufficient current to endanger the instrument, might give an incorrect reading.

These measurements are then averaged daily and also for the month. It should be borne in mind that the measurements are limited to the capacity of the instrument used; this, however, is a matter of minor importance, as the value of insulation in practical work depends not on its highest, but on its lowest resistance.

Among our circuits operating Thomson-Houston arc lamps (about 10 ampères at 50 volts) we have four covered respectively by P. & B., Simplex, Grimshaw, and Okonite insulation.

The external conditions of these circuits are nearly the same. The Okonite circuit, in use 18 months, is $2\frac{1}{4}$ miles long and operates 50 lamps; the P & B. circuit, in use 15 months, is $2\frac{1}{8}$ miles long and operates 40 lamps; the Grimshaw circuit, in use 18 months, is $2\frac{1}{8}$ miles long, and on it are 24 lamps; the simplex circuit, in use 13 months, is $3\frac{7}{10}$ miles long and operates 40 lamps.

During the 12 months ending Jan. 1, 1890, measurements of insulation of these circuits have averaged:

P. & B., 435,702 ohms; Grimshaw, 891,392 ohms; Simplex, 895,122 ohms; Okonite, 900,212 ohms.

The average lowest resistance for the 12 months is as follows:

P. & B., 35,200 ohms; Grimshaw, 160,400 ohms; Simplex, 163,871 ohms; Okonite, 172,913 ohms.

Loss of service during the year directly attributable to grounds is on the P. & B., 301 lamp hours; Grimshaw, Simplex and Okonite, none.

The PRESIDENT: Before having a general discussion on this topic and the one preceding it, we will hear from Mr. J. E. Lockwood, of Detroit, Mich., upon how to locate grounds upon arc circuits.

Mr. Lockwood then read the following paper:

HOW TO MAKE ARC LIGHT CIRCUITS SAFE.

Gentlemen of the Convention: I come before you to-day to speak upon a subject which I am satisfied is of such importance as warrants a very careful investigation, and I am satisfied that if we make it in a thorough manner and then apply it to the best of our ability, the knowledge thus gained, we will have done more toward ending the cry of the press and people about the dangers of electric lighting than could possibly be done in any other manner.

The subject of my paper is, "How to Make Arc Light Circuits Safe."

Now, I do not mean to convey the idea that arc light circuits are not and will not always be dangerous under certain circumstances, but I mean that, with our present knowledge and with the application that can now be obtained to enable us to apply same, we can make arc circuits so safe to our employes and the general public that accidents will be of such rare occurrence as to attract no advere criticisms from either the press or the people.

We all know that the past year has been productive of more harm to electrical interests than any other year since we started, and there is no gainsaying the fact that *all* the result of accidents were from arc light, such as are usually termed "high-tension circuits;" for although there have been a few accidents due to other causes, they, of themselves, would cause no comment. Let us then benefit by the lesson we have had, and from this time forth see that nothing is left undone to prevent its reoccurrence.

Now, the first thing to do is to locate the causes of dangers and troubles, and then next to show a way to avoid them. As to the cause, we all know that the prime cause in almost every instance is a "grounded circuit," and though there are other things to guard against, I think that if we can effectually guard against "grounds," or to almost the same end be sure that the instant a ground appears that fact will be known and the ground located so that it can be quickly removed, the other causes will not be likely to result in much trouble. This can be more properly and effectually taken care of by issuing good and complete instructions to our employés, and then seeing that they are enforced, than by means of appliances at our stations. Now, to avoid the dangers resulting from grounds, we must first provide some means or system to enable us to know where a "ground" comes on to a circuit. It has been suggested to make a permanent ground in each circuit, through a high resistance, with an annunciator drop in circuit, so that when a second ground occurs, a portion of the current will be shunted through the high resistance and drop, and thus cause the drop to fall and indicate the coming on of the ground. An apt suggestion in regard to trying these devices has been made, viz.; that, before asking others to try it, the inventor be first connected to a high tention arc circuit, and then make the second ground through his body. If this suggestion is carried out, I do not think this particular inventor will bother us any more.

Many other ideas have been advanced and schemes tried to accomplish this result, but to-day I know of but one system that will automatically indicate a ground the instant it appears on a circuit, and that of itself creates no danger. This is the Rudd ground alarm, the invention of Professor Rudd, of the Western Electric Company, of Chicogo, and it is in use at the station of the Chicago Arc Light and Power Company, and I believe at a few other places. The Rudd system was described and illustrated in the *Western Electrician* of Aug. 24, 1889.

If this system is used a ground will be indicated the instant it appears, and we then have before us the problem of locating same. If, however, the above system is not adopted, the next best thing to do is to test every circuit regularly each day at certain specified hours, and I should advise a test every two or three hours while the circuit is in operation, and two tests while not, the last two to be made, one the first thing in the morning, the other just time enough before starting up to give sufficient time to remove the ground if one is found to exist. If any circuits are operated all the time or nearly so, all four tests should be made while in operation at regular intervals.

As a result of my experience and observations, I believe that the majority of grounds occur while circuits are in operation and that the best time to test for the same is at this time. In most cities there are many circuits that never have all their loops thrown on except when the circuits are in operation, and, therefore, this is the only time when the circuits can be tested in their entirety. To make these tests would require appliances to test both live and dead circuits, or in other words, "circuits in operation" and "circuits not in operation." For the first or live circuits I would advise the use of any of the appliances which I will describe further on, that can be used to locate the grounds. For the second, or, "dead" circuit, I would advise any of the testing sets now made by electrical instrument manufacturers, which are a combination of rheostat and galvanometer on the Wheatstone bridge principle, and which will test satisfactorily up to at least one megohm. A brass plate at the switchboard should then be provided and the same connected well with the earth. Now, by connecting one wire from your testing set to this ground plate and the other to a terminal of a circuit, your circuit and the earth become portions of the circuit, and the ground connection between those two can be measured. The total resistance less the resistance of the portion of the circuit between the set and the ground will be the resistance of the ground connection. No connection of less resistance than one hundred thousand ohms should ever be allowed to exist, and preferably not less than one megohm.

We now come to the locating of grounds when they are found to exist, and we will first take up grounds on dead circuits. To carry out this work we need the combined galvanometer and rheostat already spoken of, and the principle upon which the share should be applied is to divide your circuit into two parts by means of a cut-out box provided for this purpose or other convenient means, and then to find upon which of these two parts the ground exists. After having determined this, we can then connect the two parts of the circuit together, and test next from a point about midway in the part upon which the ground exists, first separating the portion of the circuit leading to where the first test was made, from that portion leading beyond this point. If the ground is still beyond this point, we must close the circuit here, and again open farther on, and thus finally locate it. But if the ground is located on the portion of the circuit leading to where the first test was made, we then know the ground to be between that point and the point where we are now testing. We can thus, by dividing and sub-dividing the circuit, locate the exact portion of the same upon which the ground exists. As an adjunct to the foregoing, and as a convenient means of cutting the current off from a portion of the circuit without affecting the whole, as is sometimes necessary on account of a fire, it is advisable to divide each circuit up into four or more sections and to provide cut-out boxes, so that any one or more of these sections can be cut entirely out of circuit.

In testing for grounds each section could then be tested separately and thus locate upon which one the ground exists so that if necessary all of the circuit but the grounded section could be started up, and then as soon as the ground is removed from this section it could be cut in.

In addition to providing these cut-out boxes loop circuits only should be put up, their advantages being too well known to need any explanation.

We now come to the locating of grounds upon live circuits. I will first describe the system used by Mr. Law in Philadelphia, it being the same as I have used in testing high voltages for the last three years, and if I make any errors I trust Mr. Law will correct them. The principle of this system is that high voltages can be easily tested with ordinary appliances such as incandescent lamps and ordinary voltmeters, if we test by steps, to do which as many incandescent lamps of as nearly as possible a uniform resistance should be connected in series as there are arc lamps on the largest circuit to be tested. If, then, this series of incandescent lamps be connected across the terminal of the dynamo or circuit where the greatest difference of potential exists, as the incandescent lamps are connected in series, and as there are as many as there are arc lamps on the circuit, each incandescent lamp will get the same number of volts as each arc lamp. Mr. Law states that he prefers using incandescent lamps of as nearly as possible the same voltage as his arc lamps, say of from 45 to 50 volts, so that when they burn at their normal candle power he will know that they are each getting the same number of volts as his arc lamps average. Now, before going further, I would wish to explain that as the current leaves the positive terminal of the dynamo it is at its maximum voltage, which we will call 3,000 volts, and that as it passes through each arc lamp and is lowered at an average of about 50 volts per lamp, we have only to find the voltage of the current at the point of the circuit where the ground exists, and then to divide the difference between the maximum voltage and the voltage at this point by the average voltage per arc lamp to find how many lamps are between the ground and the end of the circuit at which the test is being made. If, then, we have a list of the lights on this circuit arranged in the order in which they are connected and stating which is the positive and which the negative end of the circuit, we have only then to count off the lights and thus locate the ground.

This is substantially what is done by Mr. Law with the simple difference that as he has means for cutting down the number of incandescent lamps in the series, he therefore connects one end of the series to a ground plate and the other to one end of a circuit, and if there is any indication of a ground he then cuts down the number of incandescent lamps in the series until those left in the circuit burn at their normal candle power, a number of these then correspond to the number of arc lights between the end of the circuit the test is being made from and the ground; to prove the test from the other end of this circuit and then adds to the result of his first test the result of his second one, and their sum should equal the number of arc-lights on the circuit; if, however, the number comes short he adds half the shortage to the result of each test and thus locates the ground. The ground now having been located, it simply remains to send a competent man to examine the circuit at this point and to discover and remove the cause.

My objection to this system of testing is based upon two reasons, first, because low voltage incandescent lamps are used that take about one and one-fourth ampères to bring up to normal candle power, and thus create a danger by the liability of this amount of current when passing through a light ground to cause fire and the possibility of accident to persons who may come in contact with the circuit being tested at a point far enough removed from the end at which the test is being made to cause serious results. What we want is to remove all the danger we can, not add new ones.

My second objection is based upon the very point wherein Mr. Law finds his system does not work satisfactorily, viz., that his system is not suitable to locate a weak or high resistance ground; when we want to make any certain resistance that may be in series with other resistances as small a factor as possible of the whole, we use high resistances for the the others, not low ones, such as low voltage lamps; why even 60 lamps of a voltage of about 50 would only have got a resistance each of about 40 ohms or less, which would only make a total resistance of about 2,400 ohms; and as to make the test it is necessary to make these lamps, or a portion of them, up to candle power, we can see that the highest possible ground resistance that could be tested would be by Ohm's law, the electromotive force divided

by the current. which in this case will be 3,000 divided by 1¼, which would give us 2,400 ohms, the highest resistance ground that we could test.

Now we should at least be able to test up to 100,000 ohms, and as with a voltage of 3,000 we could only get a current through this high resistance equal to 3,000 divided by 100,000, we could thus only get $\frac{3}{100}$ of one ampére, and we should consequently use a system that could be operated by this amount of current. Now to make our ground the least factor in the test, and as we would have only about one-half our incandescent lamps or high resistance coils in circuit in most tests we must use resistance coils and make them of such a resistance that 30 will equal at least one megohm, and thus each one would be about 33,000 ohms. As this high resistance is necessary to apply this system satisfactorily you can all see plainly why I do not approve of the incandescent lamps system. If however, incandescent lamps are used for ground testings only, those of the highest possible resistance and that use the smallest fraction of an ampére are suitable, and of all the styles now on the market the 8-candle power 110-volt lamp is the most suitable, because if as many of these lamps are used as there are lamps in circuit, they will each only get about 50 volts, and, consequently, about 1-10 of one ampére, and will thus enable us to test up to a certain resistance equal to the maximum voltage of our circuit, say 3,000 volts divided by the ampéreage 1-10 of an ampére, which would be 30,000 ohms, a great increase in range from the low-resistance lamps, which only enabled us to test up to 2,400 ohms; if lamps are used we should also use a dead-beat voltmeter, such as is made by the Western Electrical Instrument Company, and it should be connected in shunt around the first lamp of the series, which should be of enough higher resistance than the rest of the series to make its resistance, when connected in multiple with the voltmeter, just equal to that of each of the other lamps of the series. We could then, when making our tests, cut out of circuit the incandescent lamps until the voltmeter indicated as nearly as possible the voltage which our arc lamps average. The number of incandescent lamps still remaining in circuit would then correspond to the number of arc lamps between the end of the circuit being tested from and the ground. I would much prefer thus using a voltmeter and high resistance lamps to using low resistance lamps and bringing them up to normal candle power. This outfit could also be used to find the average voltage of arc lamps on any circuit, and having once determined this point, and also how many lamps the line is equal to, and then test and find out at any moment how many lamps are being used on any circuit; and if we are running a number of circuits from one dynamo we could thus find how many lamps are burning on each circuit and plan our changes and combinations understandingly. A great improvement on this would be a voltmeter to read up to five or six thousand volts, such as Mr. Law says can be made by the Weston Electrical Instrument Company, and the amount of improvement would depend entirely upon the fraction of an ampère used to operate this instrument; the smaller the fraction the greater the improvement. With such an instrument the coming on suddenly of a ground when a test is being made, even if at the opposite extreme of the circuit, would do no harm to the instrument. This instrument should be as nearly as possible dead beat, so that in testing for a swinging ground the instrument would indicate accurately the voltage at the ground, even if the connection only existed for a moment. We now come to a system of testing which, I think, a great improvement over those already mentioned, except in one particular, viz., the testing for swinging grounds. For this purpose the extremely high resistance and high capacity dead-beat voltmeter I consider better than anything else. This new system I had the fond belief up to a few days ago to be original with myself; but I find the old saying that "there is nothing new under the sun" has been again exemplified by my finding that practically the same system is in use at the stations of the Arc Light and Power Company in Chicago, it having been put in, I understand, by Professor Rudd, of the Western Electric Company of that city. The system in brief is similar to the Wheatstone Bridge, as the principle is to form a shunt circuit between the terminals of the arc circuit by means of from 60 to 100 coils of high resistance connected in series, and then, by means of any very high resistance galvanometer, finding the point on the shunt circuit from which no current will flow to ground, then, by noting at what point on the shunt or testing circuit this neutral point is the ground, for it can be easily located. In applying this system, I would provide means for cutting out of circuit any number of those coils with the idea of using at each test only as many coils as there are lamps burning on the circuit at the time of the test; then, when the neutral point is found, you can see at once, without any figuring, between what lamps on your circuit the ground exists. The advantages of this system are, first, it creates no new dangers; second, the question of how high a resistance ground can be tested depends simply upon the sensitiveness of the galvanometer; third, it is quick and accurate and cannot be damaged by grounds suddenly coming on when testing. Now, as a necessary adjunct to any of these systems of testing, there should be prepared a list of the lights and service on each circuit arranged in the order in which they are connected in the circuit, and stating which is the positive and which the negative end of the circuit. With such lists a competent lineman, when notified that there is a ground so many lamps distant from the negative or positive end, as it may be, of a certain circuit, should have no difficulty in quickly locating same, and to enable him to safely and quickly do this he should be provided with a high reading voltmeter, so that by going directly to the point where he thinks the ground exists, and testing from the circuit to the ground with his voltmeter, he could tell whether the ground was very near or not, and if not, about how many lamps were between this point and the ground. Then, by testing again a little farther on, he would immediately see whether he was approaching or leaving the ground, and thus could quickly locate same. In conclusion, I would say that I firmly believe that if we use such a system of testing as last mentioned, and equip our circuits with good lightning arresters, and some such device as the circuit openers lately brought out to disconnect the dynamo from the circuit when the current ceases for an instant through the breakage of a wire or any other cause, and then see that our employes use these appliances and do their utmost to keep all lines clear of grounds, we will have few accidents and the press will have little or nothing more to say about the dangers of electricity.

This paper was received with applause, and the discussion was opened by Mr. Law, of Philadelphia, who said: I have listened with great interest to the reading of the paper presented by Mr. Lockwood, and I have been specially interested in that part of it relating to central station work. The explanation that I gave of testing for grounds is one of the first that has ever been presented to the association. It is a very good method, but still probably not as good as the one you have just listened to. It is a method that lies within the reach of all. My reason for using a low-voltage lamp was simply because it was easier to locate the ground and easier for the men that were in charge of the stations at that time to grasp the idea.

At the present time I have been experimenting in my station, and have an apparatus perfected, not knowing that others had been reaching out in that same line to test grounds by the Wheatstone method. I am very glad to see that others have made advances in that direction. I use at the present time a simple method of diagrams, which might be interesting to some of you. Perhaps others have used the same. I print a sheet of paper which is, I think, about 20 inches square, and is ruled in red lines one-half an inch apart. These lines are marked up by the streets both north and south in the section or territory through which a certain circuit will pass. In constructing that wire we started out on these red lines, and followed them by corners and routes the entire length of the circuit, marking at the terminal or station end the positive and negative side of that circuit. At the present time I am keeping the locations of lamps on that circuit simply by a lead pencil, that they may be easily erased and changed. I have a blank, called a line report, which I require my foreman of lines to hand in, with the complete report of the condition and changes in lines from day to day. As that comes in to my desk, it is very easy to rectify any changes that have been made upon that circuit. That may, perhaps, be an idea to some of you, to have a diagram of circuits from your stations.

Captain Brophy: I believe that any system of testing grounds on an arc-light circuit by a low volt resistance in the circuit of the ground is dangerous. The plumber and the gasfitter, those worthy individuals who are a terror to all electric light men, get in their work unbeknowns, and an imperfect ground is established possibly between a gas pipe and arc light circuit. It is desirable in testing to reduce the amount of current traveling over that part to the lowest possible amount. In addition to having a proper method of testing and clearing the line of the ground, another very good thing to do is to clear your lines of everything in the shape of obstructions. There may be a wire run by a boy who has set up a bell somewhere, and whose fond parents believe he knows everything about electricity. Do not enter into any arrangement by which any grounded circuit can be run on your own poles and fixtures.

Mr. Gregory: We are running about 300 arc lights in Chicago. We have our chief linemen go over that circuit and see every foot of it at least once or twice a month. We use the galvanometer to take our measurements by. We think by going over it frequently the linemen can oftentimes see defects and observe repairs which can be made in the line, where they would not be affected until a storm occurs. In that way out of seven circuits, for a period of over seven months, we have had no occasion to shut down for any line trouble. We haven't any newly-devised schemes for locating grounds. Our circuits are all underground, running through alleyways. We measure from one side of the street to the intersection of another, occasionally pull those wires up, fix them and put them back again. In that way we save a great deal of trouble. We have no air circuits at all, except where we come out of the alleyways. We come out and run into a building; if it is only one or two numbers on the street we go right back into the alleyways. We think we have saved a good deal of money in that system. Any indication of trouble is readily indicated, and we at once send a man who removes it.

Mr. Lockwood: Mr. President, I omitted one point in my paper. After we have put up our lines in the best manner we know how with our present knowledge, and equip with the best appliances we can get, using those appliances in the best way, we should keep a record of our knowledge of the grounds and their causes; and after a short time in studying these causes, I think it will be found where we can improve upon our method of construction.

Mr. Law: In reply to Mr. Lockwood, I will say that I have prepared for my ground testing a sheet on which a report is kept of every test made during the day, every two-hour test. And if a ground is discovered, if found upon the circuit, the time at which that ground is removed and the character of that ground is specified in the remarks upon this sheet.

Mr. Brophy: I would like to speak upon one topic touched upon yesterday, and that is the desirability of some method of breaking the line, without cutting with an ax, or anything of that kind; some method of disconnecting the lines in front of a building which is on fire, for the benefit of the fire department. There is no man who has studied up the sensational reports printed in regard to electric light matters as thoroughly as the average fireman. There is no man who dreads an electric wire more than he. After a wire is cut and let into the street, though it be as dead as a door nail, they do not know it. If we had some method of disconnecting the lines from the dynamo by a system of switches, so they shall know one wire is perfectly harmless, it will be of great value to everybody interested.

Mr. Law: I can say that is practiced at the present time with us, and that every central station should send a competent man to every fire with the fire department. That has been done in Philadelphia now for nearly nine years. In some cases it has become necessary to shut down a complete circuit where there was any danger of walls falling and breaking down the wires which did not return upon that same street, if a wire should return upon that same street, and there were no cut-outs provided for turning off the section beyond. I have provided in our fire wagon a cut-out which will hook over the wire, with steel pointed screws with a large wooden knob at the top, that a man can handle with perfect safety on any wire. Using that you do not have to cut away the insulation, but the point of the screw will penetrate through and make contact with the wire. Then by the use of properly insulated cutters, a man can cut loose any wire that is liable to give trouble. We have done it in quite a number of cases in Philadelphia. We cut the wires, so there is no possible danger to firemen. The firemen understand this thoroughly. They know if they come to a fire in which a wire is passing in front of a building or into a building, as a rule, the foreman of the hook and ladder company will ask me if everything is all safe. A man is generally on duty who stays by the hook and ladder companies, so they know where to pick him up at any time. The firemen have orders from the chief of the department to allow any of the electric light people to ride upon the apparatus it it becomes necessary to get to the fire quickly.

President Weeks: If there is no further discussion of this topic, with the usual instructions to the secretary it will be passed. The reports of standing committees are now in order. I will call for the report of the Committee on State and Municipal Legislation.

Mr. DeCamp: I am not chairman of that committee, but I have the report here which has been passed upon by the committee which I have the honor of representing. I will hand the report to the Secretary and ask him to read it.

Secretary Garratt then read the report of the Committee on State and Municipal Legislation, which was as follows.

1. For the sake of convenience and brevity, this committee recommends that its name be changed from "The National Committee on State and Municipal Legislation," to "National Committee on Legislation."

Membership.

2. The present membership of the committee is as follows:

California, George H. Roo; Colorado, C. H. Smith; Connecticut, John C. English; District of Columbia, Allen R. Foote (chairman); Georgia, H. W. Palmer; Illinois, C. H. Wilmerding; Indiana, John Caven; Kansas, L. A. Beebe; Maine, William R. Wood; Maryland, J. F. Morrison; Massachusetts, F. A. Gilbert; Michigan, J. E. Lockwood; Missouri, J. A Corby; New Hampshire, Alonzo Elliott; New Jersey, Henry W. Pope; New York, E. A. Maher; North Carolina, D. A. Tompkins; North Dakota, Vincent S. Stone; Ohio, Charles R. Faben, Jr.; Oregon, P. F. Morey; Pennsylvania, A. J. De Camp; Rhode Island, Marsden J. Perry; South Cerolina, George B. Edwards; Vermont, M. J. Francisco; West Virginia, John B. Gardner; Wisconsin, S. S. Radger.

A persistent effort is being made to complete the membership, so that every State shall be represented. It is hoped that a leading central station man in each of the States not represented will soon be found who will qualify as a member of the association, if not already a member, and accept an appointment as the representative of his State on this committee. The assistance of every member of the association, and of all others interested in its welfare, is solicited to secure this consummation.

Electric Executions.

3. The resolution adopted at the tenth semi-annual convention, directing this committee to use its efforts to secure the repeal of the electric execution law in the State of New York has not been acted upon. The committee thought it best to make no move in that direction while the question of the constitutionality of the law was undetermined. While reaffirming our belief that the law should be repealed, we are of the opinion that if it is to be enforced, it should be done in the most effective and humane manner. That the law may be enforced, we believe it necessary that it be so amended as to require a special apparatus to be devised for the purpose, that shall generate a current of not less than 10,000 volts. In this behalf, this committee recommends the association to instruct it to co-operate with the New York State Association in securing such amendment of the law.

State Association.

4. Since the tenth semi-annual convention this committee was engaged in the work of promoting the organization of State associations. The reason for this action is based on the fact that all legislation effecting the interests of central station companies is either State or municipal. A State association is necessary in order to provide a medium through which the central station companies doing business in a State can act to accomplish a purpose in which they have a common interest. As there is no uniformity in legislation as between States, State associations are necessary to enable the National Association to carry out the "Plan of Work" adopted for this committee in the most effective manner. Through the grouping of central station companies into State associations, and of State associations into the National Association, the full strength of the prestige and influence of the entire industry of the country can be brought to the support of any State association or of any central station company needing assistance.

5. In pursuance of this policy, State associations have been organized in the following States: Massachusetts, Maryland (including the District of Columbia), Connecticut, Rhode Island, New Hampshire, Maine, Michigan, Illinois, New York, New Jersey.

This work will be continued until all the States are organized.

6. Membership in these associations is confined to central station companies doing business within the State. Any such company may become a member and be represented in the meetings of the State association by any one or all of its officers or employés, one of their number being designated to cast the vote of the company at the meeting.

7. While subjects of legislation have been the exciting cause for these organizations, it is expected that in the course of time the development of the work that may be accomplished through them, will render the legislative feature of the least importance or benefit. The improvements in mechanical, electrical business methods that can be initiated or perfected through the bringing together of those having a common interest in such subjects, cannot well be overestimated.

8. In view of the number of State associations now organized, and the prospect of the organization of a number of additional States in the near future, this committee recommends the association to instruct it to report for the action of its next convention, such changes in the constitution as will, in its opinion, best provide for the membership and representation of State associations in one National Association.

Dangers to Investments in Central Station Companies.

9. Closely allied with the subject of legislation is the subject of the business methods by which manufacturing companies seek to make sales of their apparatus. As this committee was created for the purpose of instituting measures for the protection of the capital invested in electrical central stations, it considers the subject of the competition of manufacturing companies with central station companies for public lighting contracts to be a most proper subject for the consideration of the association.

10. Within the last six months every dollar invested in electric central stations has felt the depreciating influence of an excited and misinformed public opinion. From such a cause these investments must continue to suffer until the means is found of furnishing the public with information that it can accept as being reliable, impartial and authoritative. While the damage done in this direction is great, it is not vital. The evil can be corrected.

11. Of a different character is the damage done to central station instruments by those manufacturers who have, either openly or under cover of other names, sought to create a market for their apparatus by underbidding an established local company in its proposal for a public light contract. A low bid for public lighting is invariably used as a means of obtaining a franchise and the right to do business in a city or town in opposition to an existing company. Manufacturers have acquired their power to do this through the wealth and prestige they have gained by supplying existing companies with their apparatus. No demand can more just than this:

"The value of investments in electrical apparatus and construction that have been made on the basis of manufacturers' representations of earning capacity, must not be depreciated by the cutting of prices, by or through the assistance of manufacturers."

12. This evil is vital. In destroying the profits of the business, the reason for its existence is destroyed. It is folly to discuss the mechanical or electrical efficiency of a plant, if its commercial efficiency is to be destroyed by cutting the price to be received from the service it is to render, to a point which destroys all possibility of securing a fair profit for the use and risk of the capital invested in it.

13. For the correction of this evil, the association must rely upon the work to be done by the co-operation of all central station companies to secure reasonable legislation and just conciliation.

President Weeks: You have just listened to a very important report from the Committee on State and Municipal Legislation. This committee has been actively engaged during the past six months in the work indicated in the

chairman's report. Very much has been accomplished that will greatly strengthen the national electric light interest, and the work of this association. There is in this report, however, one point to which I desire to call your attention. I believe it recommends that the matter of underground conduits and conductors be referred to this committee.

Mr. JOHNSON: I think you are mistaken.

Mr. PERRY: There is no reference whatever to underground conduits made in this report.

President WEEKS: I was given to understand that there was. There was in the report as originally presented to me, and I supposed it was embodied in this report. What is your pleasure with reference to this report?

Mr. DECAMP: I move the report be received.

Mr. MASON: Let me inquire if the reception of this report is not tantamount to the adoption of all its recommendations.

President WEEKS: Certainly not; it is simply the reception of the report.

Dr. DECAMP: Then I amend my motion and move that the report be received and approved.

Mr. MASON: It seems to me this report covers not only a very wide range of subjects, but also deals with matters of considerable importance. I am not prepared to say that I object to anything in the report, but I must say that I am not prepared to vote for the adoption of all its recommendations without consideration. The adoption of this report by this body, I for one will say that I do not understand all the questions that are brought up in it. Might it not be referred to a competent committee rather than we should, off-hand, adopt all these suggestions. There are some things that strike me as revolutionary, though they may be the most desirable things in the world.

Judge ARMSTRONG: The gentleman's suggestion would have the effect of referring the report of this committee to another committee. I should not feel very comfortable, under these circumstances, if I were on the committee that made the report, if that action was taken. I think the suggestions of this committee are admirable, and it seems to me that they have exhaustively considered many important subjects. Whether all these recommendations ought to be complied with I am not prepared to say. I would like to receive the report, and if there are aay serious objections to carrying out the recommendations, the matter can be referred to the Executive Commitee.

Mr. MASON: I think I can state my view a little clearer. I have not the slightest suspicion that any part of the report is objectionable, but I think it is dangerous for us to adopt as a whole a report embracing so many important features. I move we consider the recommendation seriatim.

Mr. PERRY: I trust you will bear with me for a moment. I object to the reference of the report to any committee. That report is from a committee into whose hands you put certain matters, and they have reported to you. I insist that this body act upon the report as submitted, in some form; that is for you to do in your own wisdom. There are no recommendations in that report that you are asked to adopt that are revolutionary. I have not the slightest objection to taking up each section and examining it. There are recommendations suggested that have been gone over very fully. There is a broad field of state and municipal legislation which is closely allied with certain other evils. We have barely called the attention of the convention to that fact to put them on their guard, nothing more.

Mr. MASON: I then move that the recommendation be considered seriatim. In view of the remarks made by Mr. Perry I regard that as essential. There are suggestions there which would take more than a New Jersey or Philadelphia lawyer to comprehend on the instant.

President WEEKS: The secretary will read the first section.

Secretary Garratt read Section 1 of the report as follows:

"1. For the sake of convenience and brevity, this committee recommends that its name be changed from the National Committee on State and Municipal Legislation, to the National Committee on Legislation."

Mr. MASON: I move the adoption of that section of the report just read. Seconded. Carried.

Secretary GARRATT: The second clause of the report is simply the membership of the committee as read in the first instance.

President WEEKS: The membership of the committee will be as recommended in the report, unless there is some objection.

Secretary GARRATT: The third recommendation of the committee is in reference to electric execution, and is as follows:

"3. The resolution adopted at the tenth semi-annual convention, directing this committee to use its efforts to secure the repeal of the electric execution law in the State of New York has not been acted upon. The committee thought it best to make no move in that direction while the question of the constitutionality of this law was undetermined. While reaffirming our belief that the law should be repealed, we are of the opinion that if it is to be enforced, it should be done in the most effective and humane manner. That the law may be so enforced, we believe it necessary that it be so amended as to require a special apparatus to be devised for the purpose that shall generate a current of not less than 10,000 volts. In this behalf, this committee recommends the association to instruct itto cooperate with the New York State Association in securing such an amendment of the law."

Captain BROPHY: The methods used to throw discredit on the electrical execution business by parties interested in securing the adoption of certain devices for that purpose are well known, and I need not recite them; but I think we had better go slowly and not leave the association open to attack. As this resolution reads it means nothing. "A current of 10,000 volts" is meaningless, and could be used greatly to our disadvantage by interested parties.

Secretary GARRATT: I was about to speak on that point. Electricity may kill people in two ways, by nervous shock or by cooking the person, burning—them. If this is to be adopted, I would suggest two things: First, that in speaking of a current of 10,000 volts, these words be added: "If the machine be devised to deliver an alternating current, the pressure of that current shall be considered equal to the heating effect in a thin wire or carbon filament under a pressure of equal potential." That prevents this being thrown out on a technicality. I would also add that this machine deliver through 2,000 ohms of resistance not over two ampères nor less than one. That will kill the man in accordance with our ideas of humanity. A 10,000 volt machine might be devised which would be equal to the tortures of the inquisition multiplied by a great many powers.

Mr. LOCKWOOD: I move that the recommendation read that special constant potential apparatus be devised to furnish a current of not less than 10,000 volts potential, and capable of delivering not less than 20 ampères.

Mr. FABEN: The committee did not feel that it was part of their province to specify a bill for passage by the New York Legislature. The suggestion was simply made that the voltage be placed high enough to represent a blow and not a burn.

Secretary GARRATT: I will withdraw so much of my amendment as relates to the amount of current to be delivered.

Mr. PERRY: It seems to me that it would be better to let the State take care of that matter themselves. The fact is that the law has been adopted by the State and stands, and for political and other considerations it will stand, and it is impossible to procure enough votes to repeal it, and if you did so you would be obliged to pass it over again. We want, if they are going to use electricity, to make a machine strong enough to kill and have it free from the odium attached to an ordinary machine, that is what was in my mind. I do not think we ought to say anything about alternating or direct currents; it does not seem to me wise to speak of that.

Secretary GARRATT: I now withdraw my whole recommendation.

The PRESIDENT: The question is now upon the original resolution.

Mr. LOCKWOOD: I move to amend by adding the words: "And capable of delivering a quantity of current unquestionably sufficient to kill."

Capt. BROPHY: With one ampère of current and 10,000 volts it is a good deal like killing a mosquito with a 10-ton hammer to attempt to execute a criminal. If you take any notice of this at all, it seems to me you are putting yourselves in the position of killing a fly with a club by recommending the adoption of special devices for killing criminals.

Mr. MASON: I like what Captain Brophy has said, but I hope that if they will use electricity for this purpose they will do it by machine specially devised for that purpose of killing, and not for light.

Mr. DECAMP: Cannot Captain Brophy's suggestion be carried out by striking out the words "That shall generate a current of not less than 10,000 volts"?

Mr. PERRY: This committee had in mind the very thought which Mr. Mason has expressed. I am here as the exponent and champion of no system. The fact that the State of New York had adopted certain machines to do this work would be a serious disadvantage to that particular make of machine. Any sensible business man who has watched the matter knows the condition of the public mind on the subject, and we thought, if possible, to remove the lightning business far away from the killing business, and make the line of demarcation so broad and so sharp that it would not be possible for the reaction which otherwise might come. If they build a special machine for killing, and then come out and announce that they kill at 1,000 volts, make the law state that it shall be 10,000 volts, and then that cannot be trifled with; for no executioner acting under the law would dare to announce that he had fulfilled its mandate in any other way except as provided by the statute. That is what we had in mind: that if we leave this open that they will construct a machine of such voltage as they choose, and they can come out and strike the very blow from their special machine that they originally meant to strike by securing an ordinary standard commercial machine. With that we are in a position to relieve the electric lighting commercial machine from the odium of furnishing an ordinary instrument of execution for criminals. I hope the section will stand as it has been presented, with the simple amendment, if Mr. Lockwood desires to add it. of a quantity of current that will insure the desired result beyond a question.

Mr. DECAMP: I think Mr. Perry expresses very clearly the sentiments of the whole committee and the idea that they had in making that report. We cannot alter the law. The committee which has had it in charge find that there is a strong tendency to keep it on the statute book; electric execution has got to be the law of the State of New York. Ten thousand voltage may be to some scientific people a meaningless expression, but if the State authorities cannot use less than that the parties who are advocating that are interested in having a sure death. A bungle of an electric execution, or one or two of them, means the repeal of that law, just as sure as we are here to-day. The sentiment worked up on that subject is purely on the ground of the humane method of the execution of criminals. Just as soon as the public see that it is not humane, it is very easy for us, if it is necessary to take any action at all, to have that law repealed. Therefore, I think, if the resolution stands as it is it will accomplish the object we have in view just effectually as we can do it in any way.

Mr. MASON: I would ask whether after we have put ourselves on record by a resolution passed at New York, and I am not sure but that was repeated, as being in favor of this business, is it necessary that we should eat our words? Can't we work just as strongly without any action on the part of the association? Do the committee need our action?

President WEEKS: I will say that that matter was presented in strong language to the authorities in the State of New York on former occasions, and my idea in raising this point was that the action of this association, which is a semi-scientific body, be not unscientific, it seems to me that this section can be a very simple amendment be made to meet all the requirements. The committee thought they should receive some support.

Mr. PERRY: I think there is something here to guard, and that is the interest of electric lighting throughout this land, and no one can deny that it is important, if it is possible, to draw a broad line between the killing machine and the commercial lighting machine. The committee arrived at the conclusion after a very careful examination, that we cannot stop the action of the law; but the next best thing is to so far relieve commercial apparatus from the odium of being used for that purpose, to draw the line so that while the opponents of high tension are in the ascendency it shall not appear that they have been killed with a commercial machine or with a commercial potential, a potential used in every day work. That was the point with the committee, to relieve the commercial apparatus from that odium.

President WEEKS: I wish to say that some few months back I visited Mayor Maher, who was the chairman of the committee appointed at our last convention to present this matter to the Governor of New York, with a view of finding out what had been accomplished and what might be done, and he told me that he had seen the Governor and the Governor had expressed himself very positively as against doing anything in the line of the petition which we had submitted to him. I then suggested to Mr. Maher that in order to relieve the commercial apparatus and avoid any strife between commercial interests, a recommendation be made to the authorities to have special apparatus devised upon the specifications of some eminent scientist who had no connection whatever with any commercial interest. Mr. Maher said that he thought something could be accomplished in that line, and that he had no doubt that, if that line was followed up properly, the result could be accomplished in that way. While I have heard nothing from him on this subject, I understand from the chairman of this committee that this matter has been followed up, and that they have hopes of accomplishing by this means the desired results. I only wanted to have the action of the convention go out as technically correct.

Mr. FRANCISCO: As a member of the committee, I want to say that the committee has spent a great deal of time in the investigation of this subject; they have not gone into it superficially, they have gone thoroughly into the matter and investigated it in all its phases, and have decided that that was the best plan that could be adopted, and I hope that the report will be adopted.

The motion of Mr. Mason to adopt the section as read was then put and unanimously carried.

The reading of the report was continued and upon its conclusion Mr. DeCamp moved the adoption of the recommendation to appoint a committee on the revision of the constitution.

Mr. MASON: I move that a committee be appointed upon the revision of the constitution, the committee to choose its own chairman.

Mr. DECAMP: I move to amend that by adding that the committee also formulate by-laws or rules of government.

Mr. Mason accepted the amendment, and the motion as amended was seconded by Mr. Perry.

The motion to appoint a committee of five was then put and carried, after which Mr. DeCamp moved the adoption of the report as a whole, which motion was carried, and the report adopted.

Mr. Gerald W. Hart then read the report of the Executive Committee as follows:

REPORT OF EXECUTIVE COMMITTEE.

The executive committee has confined its work largely to the present convention; other matters connected with the association having been delegated largely to special committees.

The following committees have made reports at this convention, and the reports have been accepted and spread upon the minutes:

Committee on Underground Conduits and Conductors, E. T. Lynch, Jr., chairman.

Committee on Harmonizing Electric Light and Insurance Interests, Mr. P. H. Alexander, chairman.

Committee to confer with Mayor Grant in regart to the International Exposition of 1892, Dr. Otto A. Moses, chairman.

Committee on Electrical Data, Mr. A. R. Foote. chairman.

Committee to Memorialize Congress on the Abolition of Custom Duty on Copper, Mr. C. A. Brown, chairman.

Committee on Standardization of Potential on Electric Street Railways, Mr. E. T. Lynch, Jr., chairman.

The National Committee on State and Municipal Legislation, Mr. A. R. Foote, chairman.

The work upon which these committees have been engaged is of great importance to the association, and the reports show that the subjects intrusted to them have been carefully considered, and a great amount of work accomplished. The secretary informs us that the number of communications from these committees which have gone out to the electrical public exceeds twelve thousand.

Owing to the fact that the members of the executive committee are so widely separated, but one meeting has been held prior to the present session since the Niagara Falls Convention, although the members have been in constant communication.

At the above named meeting, held at New York on Oct. 25, the date of the present convention was decided upon, and a general programme was outlined; also an important resolution upon the compulsory use of underground systems for high potential circuits was passed.

The finance committee, a sub-committee of the executive committee, has audited and approved the accounts of the treasurer. A committee on credentials has been appointed for the purpose of examining the credentials of the active members.

The finances of the association have never been in better condition than at present, or the future more promising. The experiment of the past year of having the headquarters of the association at New York has proved to be an entire success.

Since the last convention there has been a net gain of 61 members; the total membership being now over three hundred. At a recent meeting the following names were unanimously recommended for honorary membership in the association: Sir William Thomson, Prof. Henry A. Rowland, Mr. Charles F. Brush, Mr. Thomas A. Edison, Prof. Elihu Thomson, and Mr. Frank J. Sprague.

The report was then voted upon by a standing vote, and unanimously adopted.

The convention then adjourned until three o'clock, P. M.

AFTERNOON SESSION.

The meeting was called to order at three o'clock by President Weeks, who said: Before proceeding with the phonogram from Mr. Edison, we will hear from our newly-elected president of the National Electric Light Association, Mr. Marsden J. Perry, of Providence, R. I.

Mr. Perry addressed the convention as follows:

Mr. PRESIDENT, LADIES AND GENTLEMEN: I am deeply sensible of the honor which you have conferred upon me by electing me as your president. I know at our conventions in Chicago a year ago there seemed to be a critical moment when a strong man and a true one was needed for the position of president of this association, and it came to me on the instant that we had with us at that time the very man—a man of scholarly tastes, exceptional business ability, sound scientific acquirements and the necessary firmness for an executive officer. His name was Edwin R. Weeks, of Kansas City, Mo. (Applause). Mr. Weeks accepted the honor, and I assure you that when he did so it took a man of considerable courage, and out of some confusion has arisen the present occasion, our sixth annual convention, by all means the most successful, the most instructive one that we have ever held. The history of the National Electric Light Association is but five years old, in point of time, but the science and its application commercially has advanced 100 years. We assembled here to discuss the topics of interest to us, and now that we have about concluded our labors I wish to thank you in behalf of the National Electric Light Association for the wealth of hospitalities which we have enjoyed here in your city and at your hands. (Great applause.)

You, sir, Mr. President, have nearly finished your official course and are about to lay down the duties and the respon-

sibilities—responsibilities in the acceptance of this office of which I am not unmindful. But in separating yourself from the office, you leave this association under a debt of gratitude and obligation that it will take long to repay. You take with you into your unofficial life a bond of sympathy, a warmth and depth of feeling, that will not soon be broken, marred or forgotten.

Gentlemen of the convention, the grand results which have been achieved from so small a beginning have not been accomplished by a single hand. They have been the result of united effort, and I shall rely upon your hearty co-operation during the coming year, so that we may, if possible, repeat again the glorious record of the past year. I thank you once more for the honor which you have conferred upon me. (Applause.)

Pres. Weeks: We are fortunate in having with us on this occasion one who has been for years intimately connected with Mr. Edison, one whose name has stood for the Edison interests throughout America; one whom I have, on urgent solicitation, succeeded in inducing to address you. I take great pleasure in introducing to you Mr. Edward H. Johnson, of New York City.

Mr. Johnson then addressed the convention as follows:

Having been associated with Mr. Edison in the laboratory and out of it almost constantly for the past twenty years, I am necessarily more or less familiar with everything he has done. The phonograph, however, is an invention with which I am particularly familiar. Therefore it would seem appropriate that I should comply with the request of your chairman and say a few words to you on that subject. At first he only called upon me to explain the operation of the instrument, the principle upon which it acts, and to that I assented. Then he broadened out his request, until finally he wishes me to go somewhat at length into the history of the instrument and the whole subject. To do Mr. Edison justice, and to do myself justice, I could not well do that. I have agreed, therefore, simply to relate the circumstances under which the phonograph had its origin, to explain the instrument to you, and then call upon the gentlemen who have the device in charge to operate it for your benefit.

When Professor Bell brought out the magneto telephone, with which you are not only familiar but which your children now know, Mr. Edison conceived the idea of amplifying the voice of the telephone, so to speak, by producing a transmitting apparatus which would generate a much stronger current than Mr. Bell's instrument did; and thus by operating upon Mr. Bell's instrument as a receiver, produce a much more audible and distinct vocalization, and render the instrument of much wider commercial value. It was in the course of these experiments, which ultimately led to the carbon telephone transmitter, now universally used throughout the world, and which you all recognize as the instrument to which you address yourselves when you are speaking in the telephone—it was in the course of his experiments with that instrument that he conceived the idea of the phonograph. It did not dawn upon his mind, or, for that matter, upon the minds of any of us associated with him at the time, just what he had done—produced a talking machine. He remarked to me one evening, when he was pressing his finger lightly against the diaphragm of a telephonic instrument, and feeling the vibrations, "Johnson, if I were to put a needle in the center of that diaphragm and make a point there—an indenting point like the point on the old time Morse telegraph register—then draw a slip of paper or other easily-impressed substance underneath the needle, the vibrations of that diaphragm would be accurately recorded on the paper." Being an old telegraph operator myself, I immediately saw the force of that apparently not very sage remark, and I said, "Certainly, but what of that?" "Well," he said, "if we take that paper and start afresh with it, and draw it under the point of that needle or diaphragm, put a slight tension on it and pull the needle, it will follow the ins and outs of these indentations that naturaliy would be in the diaphragm, precisely as it did move when it made the original indentations." I said "that is true, but what of it?" "Well only this—that would be a telephone repeater. Of course, if I speak in the telephone and that produces a vibration on the receiving telephone's diaphragm, the receiving instrument is made to record these indentations on this piece of paper, and that paper is afterward drawn under the needle, the diaphragm re-vibrated, without the action of the human voice, I have only to make that second diaphragm another transmitter, and I will carry my message on again to another station. Thus, instead of telephoning within the limit of the capacity of a single instrument, I will telephone to those limits, and then automatically repeat the speech over another circuit to the limits of the second circuit. In other words, I will make a telephone repeater that will be the exact counterpart of the telegraphic repeater, so well known in general use." I said "it looks feasible; it looks practicable." That was the end of it for the time being. Neither one of us—nor Mr. Batchellor or the other laboratory associates of Mr. Edison—thought any more about it for a long time. I was in somewhat straitened circumstances at the time, as we all were, owing to the fact that we had spent some six years in developing a system of electric automatic telegraph, which we sold to our friend Mr. Gould, who was several years paying for it and has not yet settled up entirely. The situation was that we had to look around and see what we could do to earn our bread and butter. Mr. Edison has since found a way of earning his. I had to strike out in some new direction; and it occurred to me that it would be a very good idea to go around to the leading watering places, it being summer time, and exhibit Edison's telephonic apparatus, particularly the musical telephone, describe it to the public, and to those who seemed to be very much interested in those acoustic experiments of Mr. Edison and Mr. Bell at that time, and make a little money in that way. I did it by having my singers stationed in the Western Union telegraph building in New York, having my receiving apparatus in a house like this at Saratoga, Buffalo or Rochester, four or five hundred miles distant from New York, and reproducing the voices of these singers to my audiences at those distant points. It was very successful. A great interest was being aroused in the subject just at that time. In the course of one of my lectures, or improvised talks, it occurred to me that it would be a good idea to tell my audience about Edison's telephone repeater, at Buffalo, which I did. My audience seemed to have a much clearer appreciation of the value of the invention than we had ourselves. They gave me such a cheer as I have seldom heard. I did not comprehend the importance of the device at the time; but the next morning the Buffalo papers announced in glaring headlines, "A great discovery: A Talking Machine by Professor Edison. Mr. Edison's Wonderful Instrument will Produce Articulate Speech with all the Perfections of the Human Voice." I realized for the first time that Edison had, as a matter of fact, invented a talking machine. The immediate importance to me was that this created a sensation, and I had very large audiences in all my entertainments thereafter. Realizing that and having had sufficient experience by this time to profit by such things, I made a special point of this feature in my next entertainment, which was at Rochester, and I had a crowded house—one that did my heart good—and my pocket, too. That satisfied me that I had better go home and assist in perfecting this instrument. I knew, from my own experience in the matter, that it was a comparatively simple thing to do, so I cancelled thirteen engagements and went back home with these newspaper clippings. I went straight down to the laboratory, which was then at Newark, and I said: "Mr. Edison, look here. See the trouble you have got me into." He read these things over and said: "That is so; they are right. That is what it is—a talking machine." I said: "Can you make it?" He said, "Of course. Have you got any money?" I says "Yes, I have a little, and I had—a little." He says "Go to New York and get me three feet of stub steel an inch and a half in diameter, and get me a piece of brass pipe four inches in diameter and six or eight inches long, and we will make it." I took the next train to New York and got the material and took it back and went to work. Within twenty-four hours we had a little revolving cylinder turned with a crank and a simple diaphragm needle, which I will explain presently, wrapped a sheet of tin-foil around the cylinder, and gave it the original phonographic sentence "Mary Had a Little Lamb." Then we set it back to see what the instrument was going to do about it. It came out to our entire satisfaction. Not as clear as it does to-day, but it was "Mary Had a Little Lamb," sure enough. That was the original phonograph and the starting point of an invention which, notwithstanding all that Mr. Edison has done since, notwithstanding my high appreciation of what he has accomplished, notwithstanding the commercial value—the vastly greater relative commercial value—of his subsequent inventions, is to my mind the greatest thing he ever did, and which as a matter of fact, is the invention which has carried Mr. Edison's fame and name outside of the comparatively limited technical circle in which he was then known, throughout the civilized world. (Great applause.) To-day the simple announcement that somebody, it makes no difference who he may be, known or unknown, is going to make a few remarks about Edison—that simple announcement is quite sufficient to crowd the largest auditorium with the most intelligent members of any community in this country or abroad. And I speak from experience when I make that statement.

Now, a few words in explanation of this instrument, and then you shall hear it. In the first place there is a mistaken idea as to the character of the instrument. It is popularly supposed to be an electrical instrument, because it is the invention of the greatest of all electrical inventors. It is not an electrical instrument at all. It is a mere bit of mechanism; it is a mechanical arrangement, pure and simple. It is necessary to have a revolution of the cylinder, and to get that mechanical motion you must have some motive power. As I explained, the original machine was turned by hand. Others have been turned by water motors, gas motors, etc. This instrument on the platform, I see by the electric cords, is operated by an electric motor. That is a matter which has no significance in relation to the machine; it is merely the motive power to turn the instrument, and is no part of it. The instrument is simply mechanical. Its principle is this: When I speak I throw the air into vibration of a given form. That strikes upon the ear and produces on the auditory nerves certain sounds, or rather they convey to the brain certain sensations that we term sounds. These sounds are infinite in variety, but they have an intelligent meaning to the brain, that meaning being simply a matter of education. It follows, therefore, that if I can produce these vibrations on the air, by other than my voice, but precisely and identically these vibrations, I will produce upon the ear, and consequently upon the brain, precisely the same sensations, and they cannot mean anything else in the one instance than in the other. This invention is nothing more or less than an instrument which will accurately receive and record those vibrations, and retain their character, form and number with absolute precision, and then mechanically do the work by operating something which will contribute again to the air all those peculiar waves of the vocal chords of precisely the character and form of the vibrations that it originally received. If it can be done, you will of course at once perceive that the instrument, although a bit of mechanism, if it has the capacity to reproduce these vibrations, necessarily has the capacity to produce upon the brain precisely the same sound that the vocal chords produced in the first instance. Therefore what we want is an instrument that will do that. Now let us see how we make an instrument of that kind. You take anything, no matter what, a piece of paper like this (indicating) and utter a sound, the musical note "do" for instance, and in touching it with your finger on the opposite side, you feel the vibration. Very well, we will call that the diaphragm—a paper diaphragm. We will put that in a suitable frame, and hold it in such a position as we want to. Then we will attach to the centre of that diaphragm—because the centre is the point of the greatest amplitude and the greatest vibration—a needle—not a sharp-pointed needle, but a needle whose point is comparatively sharp, one that will not scratch, but will simply produce the indentations upon that yielding substance. Take and arrange that in such a way that the needle of the diaphragm rests against the surface of the revolving cylinder. Now, we will put around the revolving cylinder that substance—paper is a little too hard for the needle to indent, of course; tinfoil is much better, and it was therefore used for a long while, so we will say tinfoil for the time being. We will put around that cylinder a sheet of tinfoil, and we will adjust this instrument so that the needle will press slightly against that tinfoil. Now, we will revolve the cylinder with a screw attachment at the end, so that the cylinder shall go past, transversely, in front, of this needle, very gradually, so as to present a constantly new surface of tin foil to the needle. When you speak against the diaphragm and cause a vibration of the needle while the tin foil is passing in front of it, you will necessarily produce on the tin foil indentations of precisely the same number, and of a depth corresponding to the amplitude of vibration of the diaphragm, exactly the same as the diaphragm yields, and that will yield precisely the same as the air yields that has been put in motion by the voice. Consequently, you have an absolute record on the tin foil of the vibration of the air affected by the vocal chord, not only in number, but of the same character in all other particulars. Now, if you will reverse this action, this cylinder, send it back again, turn it backwards, if you please, then drag the needle back again, on to these indentations precisely where they began, and do nothing but simply rotate that cylinder, so as to cause the needle to traverse the ground over again, thus going in and out of all the little indentations, you get precisely the same effect upon the diaphragm as you had originally; because, it now being moved by the rough path, so to speak, which it previously created, it must necessarily follow the same ups and downs. So that you get the diaphragm in motion again as it was before, with the net result that the diaphragm contributes to the air precisely the same movement that the air had sent out from the diaphragm. Consequently you get perfectly articulated speech. That is all there is to the instrument.

This instrument lay dormant for twelve years. Mr. Edison went from his telephonic experiments immediately into electric light experiments, and consequently gave no attention to the phonograph, always saying to those of us who would urge him to take the matter up: "When I get through with this I will take the phonograph up; that shall be the next thing." But the electric light came along, and before he got through with the carbon transmitter he took that up, and the phonograph was ignored. Then he promised to take it up when the electric light matter was settled. Before he had satisfied himself with his work in that direction, others took up the phonograph and worked on it to considerable purpose, namely, Messrs. Taintor and Bell. They endeavored to make a phonograph which was then merely a scientific novelty. In other words, to do for Edison's phonograph what Edison did for Bell's telephone, make it a commercial as well as a scientific success. They succeeded in developing what has proven to be the correct principle; namely, that instead of making indentations in this plastic substance, wax, which is now the thing used, they made a little cutting knife, and actually cut the material out with each vibration.

The result of that was an instrument which, while it did not speak and was not intended to speak in the original voice, as the old tinfoil phonograph did, yet spoke with such distinctness that if you placed the tubes to your ear, while the voice was low, it was wonderfully clear and the utterance was easily comprehended. They brought out on the basis of that improvement what is now universally known as the graphophone, which is simply the phonograph turned the other way around. They did not claim to have anticipated Mr. Edison in this great discovery. They simply claimed to have perfected Mr. Edison's instrument and thus brought it into the realm of commercial utility; but they did not make the progress that they expected, and Mr. Edison then took the subject up again, and the result of his efforts in that direction was the perfected phonograph. Consequently we now have the graphophone and the phonograph.

A very shrewd gentleman in New York, recognizing the great possibilities of this thing, went to work to acquire the ownership of both. Consequently the North American Phonograph Company to-day is the owner of all the rights of the graphophone and the phonograph, and now being but one common instrument, the aim in this instrument is to give you all that is known of the last and best development of this wonderful apparatus, which is to record what we say, keep it for any length of time, and then reproduce it for any purpose we may wish with as perfect a retention of the character and quality of the original voice as the telephone of to-day in its best form. We will now endeavor to hear the instrument (applause); and I want to say that this instrument, although it is fitted up here with a rather elaborate contrivance so that you may hear it, is designed expressly not to do that which we are going to call upon it now to do, namely, to talk loud. It is designed to address itself to the individual ear. That is because the instrument is intended for commercial use. I do not want the message or letter which I have dictated in my study at home and sent to the office to have transscribed by the typewriter to be heard by everybody in the room; consequently the instrument is designed to speak in a low, clear tone to the ear. We can make them speak as loud as we please, but at some loss of clearness of articulation. Inasmuch as it is impossible for everybody to assemble around the instrument, we will endeavor to make the instrument speak loud enough for you all to hear.

The phonograph was then brought into action, and after reproducing several cornet solos by Levy, reproduced the following message from Mr. Edison:

From the Laboratory of Thomas A. Edison,
Orange, N. J., Feb. 7, 1890.

Edwin R. Weeks, Esq., Kansas City, Mo.:

My Dear Mr. Weeks: When I had the pleasure of meeting you at my laboratory in December last, you suggested that I should send to the Kansas City Convention, which commences next week, a phonograph discussion upon the subject of my five-wire system of distribution, which you were good enough to assure me would prove of interest to the delegates, and ever since that time I have been trying to find an opportunity to prepare the data.

My failure to do so has been through no fault of yours, as your letters have constantly kept the matter before me, nor has it been through want of inclination on my part that I am obliged to substitute this explanation.

Certain urgent matters of business which I was unable to anticipate have occupied my attention to such an extent that I have even had to neglect the important work of my experiments.

While I could not have contributed to the success of the convention, which is already assured through its location in your enterprising city, I regret that I am unable to send something which would at least be more interesting than this apology. Yours very truly, Thos. A. Edison.

The remaining business of the convention was then taken up, and the following resolution was offered by Mr. DeCamp:

Whereas, More than $100,000,000 have been invested in central electric light companies in America; and

Whereas, The stocks and bonds of these companies have been and are being depreciated and jeopardized by a reckless and disastrous competition encouraged and fostered to a large extent by rival parent companies; and

Whereas, This course of conduct threatens the destruction alike of central station companies and of parent companies, the profitable continuance of whose business depends upon the healthy life of the central station companies, therefore

Resolved, That the National Electric Light Association appoint a committee of seven, whose duties shall be to devise and execute plans for the ceasing of the evils referred to.

Resolved, That the president appoint this committee, and that any vacancies occurring be filled by the incoming president.

The resolutions were heartily supported by Mr. Mason, Mr. Armstrong, Mr. Lockwood and Mr. Francisco, and were unanimously adopted.

The chair announced the appointment of the following committees:

On Underground Conduits and Conductors—Mr. J. E. Lockwood, of Detroit; Mr. C. H. Wilmerding, of Chicago; Mr. Schuyler S. Wheeler, of New York; Mr. T. C. Smith, of Philadelphia; and Mr. David E. Evans, of Baltimore.

On Revising Constitution and By-Laws—Mr A. F. Mason, Mr. A. J. DeCamp, Mr. E. A. Armstrong, Mr. M. J. Francisco and Mr. E. R. Weeks.

On Relations Between Parent and Sub-Companies—Mr. J. Perry, chairman, Mr. Morrison, Mr. J. E. Lockwood, Mr. F. A. Gilbert, Mr. E. A. Armstrong, Mr. E. R. Weeks.

Mr. George Cutter presented the following resolutions which were unanimously adopted:

Whereas, It seems desirable that underwriters' rules governing the installation of electrical apparatus for light and power should be the same throughout the country, and that they should be as plain and concise as would be consistent with their efficiency, and

Whereas, In order to secure the formulation and adoption of such rules it seems necessary that the authority be vested in a committee composed of representatives of all parties interested; therefore, be it

Resolved, That the Chair select and appoint a committee of five members of the National Electric Light Association, who shall have power to choose three representative electrical men to act on a committee for the purpose of devising and adopting national insurance rules, and considering any other matters affecting the joint interests of insurance and electrical companies, and be it further

Resolved, That the committee of five be requested and authorized to negotiate with the various general insurance organizations throughout the country with a view to securing the appointment by them of representatives on a national electric insurance committee, and that the committee of five report the result of its deliberations and actions at the next meeting of this association.

Mr. Mason: I wish to introduce the customary resolution, which is most fitting on this occasion. I move that the National Electric Light Association express to the people of Kansas City generally, to the railroads, the surface roads, the local reception committee, the transportation committee and all others who have extended us special courtesies, our heartfelt thanks as an evidence of our appreciation of all their generous treatment. I might add very much more, but no words that I could use would

more clearly express my deep sense of appreciation of their kindness.

The resolution of thanks was adopted unanimously by a rising vote.

Secretary Garratt announced the reception of a letter from the chairman of the trustees of Guthrie, Oklahoma, inviting the association to visit that city.

Mr. Mason suggested that the association instruct Secretary Garratt, if possible, to visit Guthrie and express to the citizens of that city the good will of the association, taking with him any members who wished to accompany him. The motion was carried.

Secretary GARRATT: I have one other letter, in reference to which I came very near violating my duties as secretary, which requires me to bring all matters before the convention. I am quite impressed by the effect the National Electric Light Association has produced upon the Western people, as appears by a letter addressed to the association by a lady who informs me that she is an eminently respectable, minister's wife, and she encloses a dollar and a half and wants us to forward to her a pair of electrical corsets. (Laughter and applause.)

Dr. MASON moved that the secretary be instructed to grant the lady's request, which motion was carried by a unanimous vote amid much laughter and applause.

Closing the convention, Chairman Weeks said: "As we have finished our business, I now declare this convention adjourned."

EXHIBITS.

Baker & Co., Newark, N. J., were represented by Cyrus O. Baker, Jr.

Noyes Brothers, Chicago, exhibited a sample board of electric fixtures.

C. H. Talmage, of Kansas City, exhibited a special form of electric heater.

H. A. Rogers, New York, distributed some handsome cards at the casino.

The Cincinnati, O., Electric Engine Company had their Mr. Emile Kahn present.

The Paillard non-magnetic watches were shown by Jaccard, the local jeweler.

The Elektron Manufacturing Company, Brooklyn, displayed a one h. p. Parrett motor.

The Standard Electrical Works, Cincinnati, were represented by Mr. E. V. Cherry.

The Jones Bros. Electric Co., Cincinnati, were represented by their Mr. W. H. Jones.

The New Haven Clock Company, New York, were represented by Geo. S. Searing.

Mr. D. S. Turner represented Woodbridge & Turner, of New York, at the convention.

Mr. J. B. Allan, Chicago, represented the interests of Edw. P. Allis & Co., Milwaukee.

The Seely Manufacturing Company, New York, was represented by President John A. Seely.

The St. Louis Electrical Company had their Chicago representative present, Mr. Chas. H. Cone.

The Walworth Manufacturing Company had their Western agent, E. L. Clark, of Chicago, present.

H. T. Paiste, Philadelphia, had a line of sample switches, etc., in the pockets of Mr. Wm. R. Hood.

Mr. Ernest Hoefer, Chicago, talked up his specialties, "white core wires," arc lamp pulleys, etc.

The Bridgeport Brass Company, Bridgeport, Conn., had their well known Mr. H. D. Stanley present.

The Royal Electric Company, of Peoria, Ill., were represented by their local agent, Mr. S. S. Jenkins.

The Southwestern Electrical Supply Company had a neat display of Grimshaw wires, Perkins lamps, etc.

The Heine Safety Boiler, of St. Louis, Mo., were represented by English, Morse & Co., of Kansas City.

The American Leather Link Belt Company, of New York, displayed some fine specimens of their handiwork.

The Western Electrical Supply Company of St. Louis were represented by their president, Mr. T. J. Wilson.

The Western Engineering Company, of Kearney, Neb., sent Mr. J. G. White to represent their interests.

The Hawkeye Electric Manufacturing Company, Davenport, Iowa, had their Mr. H. O. Woodruff present.

The Field Engineering Company, New York, had their interests looked after by General Manager C. J. Field.

Holmes, Booth & Hayden, New York, had the genial H. P. Lucas on the ground making friends on all sides.

The Western Electric Company, Chicago, had Mr. John Young on the ground to look after their interests.

The Fishkill Landing Machine Company, N. Y., distributed handsome cards showing the Fishkill-Corliss engine.

The Monitor Electric Company, Chicago, had an exhibit of a few specialties in the hands of Mr. C. G. Armstrong.

The Westinghouse Electric Company, Pittsburgh, had Mr. H. E. Longwell, their Chicago representative, present.

The Empire City Electric Company, of New York, had their interests well cared for by Mr. David Chalmers.

The Perkins Electric Lamp Company, Manchester, Conn., were represented by their local agent, Paul W. Bossart.

The Fred H. Whipple Company, of Detroit, had a nice display of their publications in the hands of Mr. Whipple.

The Montague-Woodrough Saw Company, Chicago, had their general manager, Mr. G. A. Edward Kohler, present.

The Faraday Carbon Company, of Pittsburgh, loomed up in big shape under the proper guidance of Mr. A. E. Carrier.

Mr. Geo. C. Bailey, of Chicago, talked up Roebling's wire for electrical railways and Roebling's cable for the "grip" line.

The Brady mast arm had an able exponent of its merits present in the person of Mr. T. H. Brady, of New Britain, Conn.

Clower & Harris, Dallas, Texas, were represented by Mr. D. M. Clower, who was accompanied by his son, Mr. Wm. Clower.

Vulcan Manufacturing Company, Kansas City, had their Mr. T. H. Reynolds present exhibiting the Vulcan furnace grate.

Mr. B. D. Sanborn, of Greeley, Col., exhibits the Bradner adjustable lamp pendant, for use on arc or incandescent circuits.

The Ball Engine Company, of Erie, Penn., was represented by their Chicago manager, Mr. W. B. Pearson, "one of our fellows."

The Parker-Russell M. & M. Company, St. Louis, were well represented in Dan. Russell, G. Parker, and C. W. Hazletine.

The National Conduit Manufacturing Company, of New York, had Mr. J. P. McQuade present to talk "underground circuits."

The Baxter Electric Motor Company, of Baltimore, were represented by Mr. David E. Evans, well known to all delegates.

The Phœnix Glass Works were represented by Mr. A. H. Patterson, who still retains his great popularity with electric light men.

The Rockford Electric Manufacturing Company, Rockford, Ill., displayed several Mayo motors that attracted much attention.

Mr. Carl Kammeyer, of Eau Clair, exhibited an 800-light Freeman alternating machine, with transformers and station switchboard.

Mr. H. A. Glasier quietly sized up the situation in the interests of A. Grant & Co., of Boston, and was the observed of all observers.

The Union Electric Construction Company, St. Louis, were represented by Mr. E. Ruebel, who is on the track of several heavy contracts.

Mr. A. P. Seymour, Syracuse, N. Y., exhibited "Seymour's universal carbon holder" in the section of the Standard Carbon Company.

The Triumph Compound Engine Company of Cincinnati had a handsome glass model of their engine in the hands of Secretary Hobart.

The Royal Electrical Specialty Company, of New York, exhibited Young's Automatic Safety Cut-out, Mr. T. R. Halsted being in charge.

The Bishop Gutta Percha Company, of New York, was ably represented by Ernest Hoefer, their Chicago manager, with a full line of samples.

The Abendroth & Root Manufacturing Company, New York, presented some of the delegates with an elegant work on steam boilers, etc.

Mr. J. D. Cuddihy, a wealthy mine owner at Red Jacket, Mich., attended the meetings to gather such information as would prove of service.

The Fort Wayne Electric Company had their Chicago representative, Mr. W. J. Buckley and tourist Chas. Knight, of Fort Wayne, present.

The Consolidated Fruit Jar Company, of New York, manufacturers of sheet metal goods, had Mr. Frank P. Wisner looking after their interests.

The Westinghouse Electric Company, Pittsburgh, were represented by Mr. G. F. Porter, of Philadelphia, and Mr. G. Panteleoni, of St. Louis.

The E. S. Greeley & Co., New York, had Mr. F. A. Magee present looking after their interests and renewing friendship with the western delegates.

The Washington Electric Conduit Company, of Washington, D. C., had sample conduits on exhibition in charge of their president, Hon. John Lynch.

The Evans Friction Cone Company, Boston, were present with photographs which Mr. H. J. Conant deftly used in explaining the merits of the system.

Dr. Gilbert M. Smith, of Chicago, looked after the interests of the Ansonia Brass and Copper Company, and generously distributed samples of wires, etc.

The Complete Electric Construction Company, of New York, had their general manager, J. A. Seely, present, who looked out for the welfare of all.

The Standard Underground Cable Company, Pittsburgh, had their western manager, Mr. Fred Deyenhardt, popular and sociable as ever, on the grounds.

The Phœnix Glass Company, New York, had their usual display of handsome shades, etc., for incandescent fixtures, with Mr. A. H. Patterson in charge.

The Brush Electric Company's interests were cared for by Mr. Alexander Kempt, of Chicago, C. C. Curtis, of Cleveland, and Harry A. Kinney, of Omaha.

Mr. J. A. Pentz, of Philadelphia, had on exhibition an electric meter which interested all the electric light men, several of whom placed orders for same.

The Weston Electrical Instrument Company, of Newark, N. J., had a handsome line of their standard electrical instruments on exhibition, in charge of Mr. M. Garver.

The Edison Machine Works, Schenectady, N. Y., had an unusually handsome exhibit of wires, cords and cables in charge of their New York agent, Mr. J. F. Kelly.

The Central Electric Company, Chicago, made a nice display of their specialties, especially Okonite. Mr. W. H. McKinlock and Mr. F. W. Cushing were present.

The Excelsior Electric Company had their Mr. R. J. Randolph present from the Chicago office, who let no golden opportunity pass by of making the fact known to all.

The McIntosh & Seymour engine was talked up by Mr. H. A. Glasier, the Chicago representative. H. T. Lockwood, of Chicago, represented Merchant & Co., of Philadelphia.

The Gate City Electric Company, Kansas City, had an excellent exhibition of the various lines of goods carried in stock. J. W. Mason and G. W. Johnson were present.

The National Carbon Company, Cleveland, had Messrs. W. H. Lawrence, Webb C. Hayes, and B. F. Miles present to look after their interests, with handsome sample boards.

The Crocker-Wheeler Electric Motor Company, New York, had their Dr. S. S. Wheeler present explaining the merits of the numerous C.-W. perfected motors that were exhibited.

Mr. H. Ward Leonard, the general manager of the United Edison Manufacturing Company, was a careful observer of every matter of importance that came before the association.

The Standard Carbon Company, of Cleveland, had a large sample board showing all sizes of carbon rods, carbon brushes, battery carbons, etc. Mr. J. B. Crouse is present from Cleveland, and also their Chicago representative, W. W. Low.

The Jenney Electric Motor Company, Indianapolis, had one of their new type of motors present driving a large coffee mill; also their combined switch and rheostat. Mr. Chas. D. Jenney was in charge of the exhibit, which attracted much attention.

The Houghton, Mich., Mining School was ably represented by Mr. J. T. Daniels, who is taking a deep interest in all matters pertaining to the application of electricity in mining opeations.

The National Electric Headlight Company, of Indianapolis, Ind., distributed photographs showing the remarkable power of their apparatus. Mr. L. A. Boyd and Geo. C. Pyle were present.

The Royal Silk Manufacturing Company, of New York, were represented by Mr. A. J. Mayer with a full line of silk machine towels, for use in place of cotton-waste on machinery.

The Hill Clutch Works, Cleveland, Ohio, had some fine samples of their pulleys and shafting in charge of their Western manager, S. S. Leonard, who made his debut in the commercial field.

The Detroit Motor Company, Detroit, Mich., had a 7½ h. p. motor with automatic switch and rheostat combined on exhibit in charge of Mr. A. A. Robinson, of Detroit, a thoroughly posted motor man.

The J. G. Brill Company had their Mr. Bernard H. Schmidt, of Chicago, present, explaining the merits of their No. 6 patent independent rigid truck, especially adapted for electric railway cars.

Wm. Baragwanath & Son, Chicago, had some neat banners displayed and a 2,000 h. p. feed water heater at Armour's that easily delivers the water to the boiler at a temperature of 212 degrees.

The Simplex Electrical Company, Boston, were well represented by Mr. A. F. Mason from the home office, and by Geo. Cutter, their Western agent, who had some handsome samples on exhibition.

Mr. Charles T. Richmond, president and general manager of the Thomson-Houston Carbon Company, Fremont, Ohio, was present and alive on every question touching the subject of arc light carbons.

The Pond Engineering Company, St. Louis, distribute copies of their handsome little journal *The Western Engineer* and some photographs of their special installations. Mr. F. H. Pond was present.

The Sperry Electric Company, Chicago, had Mr. C. E. Gregory present, exhibiting some of their special apparatus. Mr. Gregory won a host of friends, and will be a prominent figure at coming conventions.

Geo. Cutter, of Chicago, was present with a handsome line of specialties, such as Bernstein lamps, cut-outs, the Cutter shades, simplex wires, etc., and was ably assisted by Major D. T. Everts, his tourist.

English, Morse & Co,, Kansas City, had a handsome exhibit of machinists' supplies, belting, etc., also a miniature Ide engine and a large Ideal engine. Mr. English, Mr. Morse and Mr. Elmore were present.

The Sawyer-Man Electric Company, New York, presented each of the delegates with a handsome pocket memorandum book. Mr. P. H. Alexander, genial and courteous as ever, was present, winning friends on all sides.

The Eureka Tempered Copper Company, North East, Pa., had a neat exhibit of cast commutator segments, journal bearings, rolled brushes of pure copper and the Washburn trolley wheels, in charge of Mr. A. L. Daniels.

The Shultz Belting Co., of St. Louis, Mo., displayed samples of their leather woven link belt and their leather pulley covering. Mr. J. A. J. Shultz, of St. Louis, was present, and is said to have captured some good orders.

The New York Insulated Wire Company, New York, had their Mr. J. W. Godfrey talking Grimshaw in his usual persuasive manner, while make a handsome exhibit of wires and tape in the section of the Southwestern Electrical Supply Company.

The Pullman Palace Car Company's interests were well cared for by Mr. A. H. Bauer, who courteously cared for the thousands of visitors, railway officials and others desirous of inspecting a train so perfectly equipped as the "Electric Limited" was.

The Standard Paint Company, New York, had Mr. P. H. Hover present, who also looked after the interests of the P. & B. Construction Company, and exhibited various specimens of wood saturated with P. & B. compound, and sections of P. & B. conduit.

Chas. A. Schieren & Co., of New York, had as handsome an exhibit of their perforated electric belting as a station manager would care to see, and visitors were properly cared for by Mr. C. A. Schieren,, Jr. of New York, and Mr. F. W. Baugher, of Indianapolis.

The Okonite Company, New York, had an extensive display, including not only the ordinary run of Okonite wires, but also Mansom tape and several samples of handsome submarine cables insulated with Okonite, Capt. W. L. Candee and Geo. Manson being present.

The C. & C. Motor Company, of New York, exhibited several large motors, ranging in size from 15 h. p. to 3 h. p., as well as small motors for fans, etc. Mr. H. L. Lufkin was present from the factory, while their local agent, Mr. Floyd Platt, had charge of the exhibit.

The Charles Munson Belting Company, Chicago, had a 48-inch leather belt made for the Municipal Electric Light Company, St. Louis, and several smaller belts on exhibit. Mr. J. H. Shay was present distributing handsome leather canes and taking care of visitors in royal style.

The models of conduits exhibited by Mr. J. F. Munsey and Mr. C. F. Coles, of Brooklyn, N. Y., are well worth an inspection. The inventors claim for their conduits unusual advantages in the matter of distribution, and will be pleased to explain their special features to those interested.

Mr. George E. Palmer, western manager of the Babcock & Wilcox Company, New York, read the excellent paper on "The Economic Generation of Steam," prepared by Mr. George H. Babcock, before the association. Mr. Palmer also distributed copies of their valuable work, "Steam."

The Electrical Supply Company, Chicago, were out in full force in Department A, with a very complete line of samples of nearly every device used in the construction and maintenance of electric light and power stations. Mr. F. S. Terry was present with Geo. T. Hewes as his assistant.

The Sprague Electric Railway and Motor Company was well represented at Kansas City. Mr. F. J. Sprague was present in person, also Mr. C. A. Benton, the energetic sales agent of the company, who has a reputation for getting an order if there is an order to be had, and Mr. W. T. M. Mottram, from Dallas, Tex.

A. L. Ide, of Springfield, Ill., was present, talking up the merits of his Ideal engine, shown by English, Morse & Co., his local agents, and which had been decorated in a unique manner with red, white, and blue incandescent bulbs, that presented the national colors in handsome shape. The engine was driven by a 5 h. p., type A., Eddy motor.

The Interior Conduit and Insulation Company, of New York, had a complete line of their tubings and junction boxes on exhibition that attracted the attention of builders and architects as well as electrical contractors, and both Mr. E. T. Greenfield and Mr. E. H. Johnson had their hands full in looking after the many seekers for information.

The Thomson-Houston Electric Company is present in the shape of a big central, station and Chas. S. Rusling, their Kansas City representative, who piloted the delegates through from Chicago, and his assistant, Mr. J. Stedman, Charlie A. Ross, Edwin Floyd and George Atkinson, of the Chicago office, and R. H. Browne, of Fort Smith, Ark,. were also present.

The Eddy Electric Manufacturing Company, Windsor, Conn., were out in full force with a large exhibit of motors, including a 1 h. p. and a 2 h. p. motor and a 5 h. p. reversible elevator motor. They also have a 5 h. p. type "A" motor driving an Ideal Engine of rated 30 to 50 h. p. M. E. Baird and A. D. Newton were present from the factory, also their local agent, W. T. Osborn, and their New Orleans agent, Mr. E. H. McFall.

Mr. Geo. F. Porter, master of transportation, etc., looked after the combined interests of the Westinghouse Electric Company, the United States Electric Lighting Company and the Sawyer-Man Electric Company whenever opportunity occurred. His untiring efforts to facilitate the comfort of the delegates was most heartily appreciated by all. Every one who had the pleasure of making her acquaintance at Niagara Falls missed the little delegate then present.

The India Rubber and Gutta Percha Insulating Company, New York, exhibited a solid sample board of mahogany, four feet high by six feet long, holding on its highly polished surface end sections of various cables and conductors of their Habirshaw insulation, varying in size from 5,000 circular mils to 700,000 circular mils and from half an inch to 2⅛ inches in diameter. One special cable made for telephone service had 277 No. 18 B. S. wires arranged in seven cores of 37 conductors each, and six cores of three each. There was a section that had lain for a long time in the river at Easton, Pa.; feeder cables, portable circuits, naval marine cores, land cores, etc. This valuable sample board was prepared for the special use of the Electrical Supply Company, Chicago, the General Western Agents for Habirshaw wires.

The New York State Electrical Investigation.

The State Senate Committee on General Laws opened its investigation into the subject of electric wires for light and power on the 15th inst. at the Hotel Metropole. The object of the investigation is to determine the existing facts as to the possibility of a perfect insulation of overhead wires, and also as to the advisability of putting the wires underground. The committee consists of Senators Erwin, Vedder, Coggeshall, Van Gorder, Chase, Brown and Cantor. In the absence of Senator Erwin, Senator Vedder presided, and Senators Coggleshall, Chase and Cantor were present.

Among those present who watched the proceedings were Paul D. Cravath, counsel for the Brush and United States companies; W. H. Brown, of the United Electric Light and Power Company, and Ex-Commissioner Danl. L. Gibbens.

Col. Bliss appeared in support of a mandamus to compel the Board of Health to prohibit the use of high-tension currents, and Counsel Everett H. P. Wheeler and Lawrence Godkin represented the Edison interests.

The first witness to be examined was Coroner Levy. He was not able to give any specific information as to the death of Lineman Murray and others who had been killed by electric wires, not having had any personal knowledge of the respective cases. All the knowledge he had was derived from testimony on file in his office, which was at the service of the committee. He thought that the decrease during the past few weeks in the number of casualties by electric wires was due to the increased vigilance and additional precautions of the city authorities. He was convinced that the burying of the wires was the best way of solving the problem under discussion. His opinion was purely a lay one, as he had no scientific or expert knowledge of the subject. He was not in a position to say whether the burying of the wires was in any way disadvantageous.

The testimony of Deputy Coroner Jenkins consisted mainly of a recapitulation of the medical testimony he has given from time to time at inquests on persons killed by electric wires in this city. He thought the only way of preventing such accidents was to put the wires underground, and believed that it was not possible to effectually insulate an overhead wire. Death might be caused by a series of shocks, where a single shock of the same voltage would not prove fatal. So far as his knowledge went no fatal shock had been given by a telegraph wire. He was not prepared to state what was the maximum voltage that could be relied upon as not dangerous to human life.

William H. Brown, when put on the stand, stated that he had been given very short notice, and before testifying he asked to be allowed to prepare certain data bearing on the subject.

Col. Bliss asked permission to put before the committee at its next session expert testimony on the danger of high-tension currents, and the necessity of regulating the strength of currents allowed. He objected to the use of any number of voltages as indicating the power of a current, and insisted on the advisability of making the definition simpler: fatal currents should be called high-tension currents, and safe currents low-tension, and if this distinction were incorporated in a law, a great deal of misconstruction would be saved.

The committee adjourned to Saturday, the 22d inst.

"Which is the most dangerous, an ampère or a volt?" he was asked.

"Both are dangerous. The pressure is the thing. A man can be killed as easily by one as the other. A man might be killed as easily by a gallon of water falling on him from the height of 1,000 feet as he would be by 1,000 gallons of water falling from a height of one foot."

Mr. Edison said that the proposed legislation would not give his system a monopoly, although he admitted that it would lead to an additional investment in copper, and necessity the reminding of dynamos and transformers. Mr. Edison gave his responses in a clear tone of voice and made a most favorable impression upon the audience.

Harold P. Brown followed with an excuse for his appearing, and gave his well-known narrative of the *Evening Post* letter, the attack of the high-tension advocates, and his experience in dog killing, and finished with the reading of a collection of alleged accidents from his scrap book, all of which, having appeared in the daily newspapers of the country, were received with weariness.

Captain Hugh R. Garden, of New York, followed with an able argument maintaining that such legislation was in direct opposition to industrial advancement, and that if Virginia hoped to reap the full benefit of her natural resources, such as water powers and mines, the bill should be defeated.

He introduced Prof. Henry Morton, of the Stevens Institute, who proved conclusively that the ratio of deaths from electricity was below that of steam, gas, kerosene, horses, or even matches. He said that high-pressure boilers were safer than those of low pressure, and added that a large number of deaths cited by Mr. Brown were not due to electricity.

As several representatives of local companies throughout the State had appeared, it was decided to continue the hearing at 10 A. M. on the 12th, and at 7:30 P. M. the committee adjourned until that hour.

Judge Theodore Garnett, of Norfolk, was the first speaker recognized Wednesday morning, and in the course of his argument inquired if there was any public petition before the Legislature in favor of the bill. He was followed by Mr. Bell, of Lynchburg; Mayor Ellyson, of Richmond; Messrs. Berry and Colgate, of Liberty, Va., and others. Messrs. Howard C. Levis, Attorney, and Ralph W. Pope, electrical expert from New York City, and L. B. Stillwell, electrical engineer from the Westinghouse Electric Company, Pittsburgh, Pa, were also present. At 11:30 A. M. the committee retired, and after about ten minutes' consultation it was announced that it had been unanimously agreed that the bill be reported, with a recommendation that it do not pass, as it appeared to be a matter which came more properly within the jurisdiction of the local authorities. Superintendents M. B. Leonard, of the Chesapeake & Ohio Railway Telegraphs; Thompson, of the Richmond Fire Alarm Telegraph, and E. B. McCluer, of the Southern Bell Telephone Company, were in attendance as interested listeners to the proceedings.

The National Fast Telegraphing Tournament.

The following correspondence and notes give the latest details in regard to the above contest:

NEW YORK, Feb. 11, 1890.

In addition to the names of subscribers for the National Fast Telegraphing Tournament which have been published, the Western Union Telegraph Company and its general manager have placed themselves on the list in a manner deserving of public and detailed announcement, being especially interesting to the craft. It is shown in the following correspondence:

NEW YORK, Jan. 29, 1890.

Gen. Thos. T. Eckert, V. P. and G. M.

DEAR GENERAL: Arrangements are being made for a National Fast Telegraphing Tournament, to take place in this city in April next.

The United Press, Associated Press, the E. S. Greeley & Co., J. H. Bunnell & Co., Western Electric Company, the ELECTRICAL WORLD, and *Electric Age* have given me assurances of substantial support. These contests are far reaching in the matter of elevating the standard of the profession, consequently a direct benefit to telegraph companies. May I count upon the co-operation of our company? Very respectfuly yours,

FRED CATLIN,
Mgr. Nat. Fast Tel. Tourn't.

EXECUTIVE OFFICE W. U. TEL. CO.,
NEW YORK, Feb. 11, 1890.

Fred. Catlin, Esq., Manager Telegraph Tournament, New York City:

DEAR MR. CATLIN: Your notes of Jan. 20 and 29 were duly received, and I regret that my answer has been delayed by an illness which has kept me away from the office, and the subsequent rush of business upon my return.

It gives me pleasure to send you herewith a check for $100 as the company's contribution to the prizes to be competed for, and to add thereto my own check for $25.

I need not say to you, and through you to the operators generally, that I take a great interest in the tournament, which will show flattering evidences of their skill and of the possible achievements of the best equipped men on the lines.

I hope that the tournament will be in every way a great success, and that the best man may win. Yours very truly,

THOS. T. ECKERT,
Vice-President and General Manager.

195 BROADWAY, N. Y., Feb. 11, 1890.

Thos. T. Eckert, Vice Prest. and Genl. Manager:

DEAR GENERAL: With sincere thanks I hereby acknowledge receipt of check for $100, a contribution from our company to be added to the tournament prizes, also your personal check for $25 for the same purpose.

Still more than these, do I value your expressions of cheerful co-operation in, and hearty sympathy with the affair, and in this feeling I know I voice the sentiment of the fraternity throughout the country.

I trust the result of the contest will fully justify your expectation.

Yours very truly,
FRED CATLIN,
Mgr. Nat. F. T. Tourney.

It has been suggested that a prize be offered to operators who were in the service prior to 1865, as it would give some of the old timers a chance to show how well they have maintained their grip. The prize suggested will probably be offered.

It is to be hoped that other cities will be represented in this national tournament. Local tournaments can be held and selections of representatives decided upon, and there should be no difficulty in securing free transportation to come in such capacity.

An Attempt to Limit Voltage Defeated in Virginia.

A bill was introduced in the Virginia Legislature last month by Senator Lovenstein, the principal object of which was the limitation of the pressure on all electric circuits to 800 volts for continuous, 550 for pulsating and 200 for alternating currents. As the passage of such an act would interfere with the development of its business in the Old Dominion, the Westinghouse Electric Company took immediate steps to defeat the bill which had been referred to the Senate Committee on General Laws. After one or more postponements a hearing was set for Feb. 11 at 5 P.M. Unusual public interest was aroused upon the subject in Richmond, on account of the announced attendance of Mr. Edison. The Chamber of the House of Delegates was literally packed with an audience of about 400 people. The proceedings were opened with the reading of the bill, when Senator Lovenstein stated that it had been introduced at the request of some of his constituents; and although he was not familiar with the use of electricity, he believed the measure essential for the protection of human life. He then introduced Mr. Boulware, attorney for those who were interested in the bill, who made an eloquent presentation of the arguments in favor of the proposed legislation. He closed by announcing that he would introduce to them the father of electricity and the foremost scientist of the world, Mr. Edison, and also one of the leading electricians of New York, Mr. Harold P. Brown.

Mr. Wyndham R. Meredith, of the counsel of the Westinghouse Electric Company, the Schuyler Company, and the Virginia Electric Light and Power Company, followed in opposition to the bill. Speaking for the local companies, he said that if it passed they would be obliged to go out of the business.

Mr. Boulware then announced that Mr. Edison would prefer to give his opinions in reply to an examination which he would conduct. A series of questions had been prepared, in response to which Mr. Edison gave a popular exposition of the properties of electricity, using the action of water as an example. The impression given to a local reporter will perhaps show clearly how the excellent explanation was understood.

The Electric Limited.

Among the ladies present at the Kansas City Electric Light Convention were: Mrs. C. O. Baker, Mrs. S. S. Badger, Mrs. J. A. Corby, Mrs. A. J. DeCamp, Mrs. Geo. Cutter, Miss M. E. Cromie, Mrs. W. J. Johnston, Mrs. J. E. Lockwood, Mrs. A. F. Mason, Mrs. A. H. Patterson, Miss Paine, Mrs. C. E. Stump, Mrs. J. A. Seely, Mrs. F T. Walton, Miss Walton, Miss White, Mrs. W. R. Kimball, Mrs. W. H. Lawrence, Mrs. C. C. Haskins—and most of these went on the special train.

On leaving New York the gallant Colonel Ransom kindly remembered the ladies on the Electric Limited with an abundant offering of cut flowers, while the soldierly Candee presented each fair member with a handsome box of French bon-bons. On arrival at Chicago at 12:30 P. M. the delegates were met by a committee from the Electric Club and escorted in carriages to the club parlors, where they were welcomed in a happy little speech by President Franklin G. Beach, and were then tendered the freedom of the city by Mayor Cregier in one of his characteristic speeches, in which he quaintly alluded to the possible location of the World's Fair in every one of the dozen cities from which representatives were present.

Then followed a lunch and music interspersed with short speeches by A. F. Mason, of Boston; Dr. Amory, G. M. Phelps, A. J. DeCamp, W. L. Candee, Fred. Degenhardt and B. E. Sunney.

Many of the guests then availed themselves of the opportunity offered in the remaining hour to visit various points in the city, and all gathered at the train in time to join in the usual jolly send-off before the train pulled out at 5:10 P. M.

In the eight coaches, with two dining cars, a happier party of mortals seldom gthered, and the hours sped quickly till daylight, when the reception committee, consisting of Messrs. Harry Orr, of the Burlington route, and George M. Meyers, C. A. Ross, M. E. Bates, F. K. Holtzinger, Ed. Lasell and Ira Hubbell, who are connected with various electrical industries at Kansas City, joined the party at Brookfield, and shortly after President E. R. Weeks came on board and handed Secretary Garratt the badges for distribution, made in the form of a maple leaf in silver, with raised gold letters.

At this point also two fresh engines were attached, and the train fairly flew into Kansas City, where carriages were waiting to escort the visitors to the various hotels.

Special Correspondence.

NEW YORK NOTES.

OFFICE OF THE ELECTRICAL WORLD,
167-177 TIMES BUILDING, NEW YORK, Feb. 15, 1890.

Mr. Louis McCarthy, with the Gould & Watson Company, of 35 Hartford Street, Boston, was in town this week.

The New York Electrical Society is having some excellent meetings, and I would like to take this opportunity of adaising all nterested in electrical work and study to attend.

Mr. F. E. Kinsman, I hear, is incorporating the Kinsman Ice Harvesting Company, under the laws of this State, to introduce the electric motor ice cutting machine recently illustrated in your columns.

The Himmer & Anderson Dry Battery Company, of 20 Vesey street, is making a specialty of its new dry battery, which, they claim, is the only one that can be restored equal to new. The company includes Mr. V. Himmer and Dr. Anderson.

The New York Wood Fibre Company, of 140 Franklin Street, this city, are introducing their improved wood pulp pail, paper pails, etc., and have engaged the services of Mr. R. Coleman, recently associated with the American Indurated Fibre Company, Chapman & Meehan being the sole agents.

Mr. Chas. Wann, formerly connected with the electric fire alarm business in this city, has now connected himself with the New York office of the old Union Mutual Life Insurance Company; and he is anxious to do his old electrical friends a good turn by insuring them. His office will be at Room 54, 96 Broadway.

Eugene Munsell & Co., 218 Water street, have just issued a new and pretty standard price list of their well-known best selected electrical mica, taking effect from February 1, and subject to change without notice. There is a complete range of prices, and discounts will be quoted on North Carolina, Wyoming, and "Amber," in the sizes named. Sheet and uncut mica can also be had at special rates. This is, we understand, the first price list of mica prepared expressly for the electrical trade, and we trust that the enterprise of the firm will be duly appreciated.

The East Side Hide Association have put in an electric light plant, comprising a Continental dynamo, driven by a Rice automatic engine. T. Tripler has put in a Rice engine for an Edison plant. These have been installed through Mr. K. Fisher, 89 Liberty street, representing the John T. Noye Manufacturing Company, of Buffalo.

A. A. Robbins, of 242 Pearl street, is introducing a very handy carboy holder. It can be emptied with great safety and facility, preventing accidents and saving many times its cost in labor and waste of acid, which is unavoidable in the ordinary way of emptying carboys. It is easily adjusted to fit any size carboy, which is simply placed in the frame and held firmly by the thumb screws. This can be done by spreading the swing bands of the frame and placing the same over the carboy, while standing on the floor, and allow the bands to drop under the carboy, then place the frame and carboy in the sockets. It is endorsed by acid manufacturers as being in every way satisfactory for the purpose intended.

The Bergmann Electric and Gas Fixture Company are admirably located in elegant salesrooms, 79 Fifth avenue, which are radiant the day through with their fixtures, electroliers, chandeliers, brackets, etc. A handsome order recently finished by the company is that for the Plaza Hotel, Fifth avenue and Fifty-ninth street. In the café, jeweled plates fixtures have been fitted into the wall with 20 shields and torches of antique design in cast and finished brass for five-light fixtures, for mother-of-pearl stems; and numerous other pieces have been put in, made of cast, wrought and finished brass, composition, metal, iron, etc. in chandeliers, electroliers, etc. Mr. S. Bergmann is the presiden of the company and supervises the manufacturing department in the big works at the foot of West Thirty-fourth street. Mr. E. F. Caldwell, the vice-president, is the designer of all these new and artistic goods. Mr. P. H. Klein, Jr., is the secretary and treasurer. Mr. E. A. Whipple, is the general manager of the warerooms, 79 Fifth avenue. Mr. C. Foxwell is the New York uptown representative. Mr. J. Black takes care of Brooklyn trade, and Mr. G. H. Berg is on the road.

First Prize for the Aron Meter.—You have already announced in your columns that the city of Paris had undertaken a meter competition, in which they offered a prize for the best meter submitted. This competition, it was intended, should enable them to obtain the best meter to put on the circuits of the Paris municipal electric light stations. The report of the commission appointed to test these matters was finished a short time ago, and handed to the City Council. I now learn from Mr. A. Barthman, the representative of the Aron meter in this country, at 21 Beekman street, that the Aron meter received the highest award among the twenty-odd meters tested. The Aron electric counters, as they are called, are employed all over the world, and many are in use in the United States. They have withstood the most severe tests, and their accuracy is attested by many testimonials which Mr. Barthman showed me; among them are those from the Brooklyn Edison Company, from Prof. Anthony of the Mather Company, Prof. Laudy of the Columbia School of Mines, and many others. Mr. Barthman also informs me that the facilities for manufacturing the meter have been increased to enable 6,000 per year to be turned out, and that the price has been reduced considerably below the previous cost. Experience has shown that in order to pay good, steady dividends, a meter is an absolutely necessary part of the equipment, and the Aron meter seems to meet the want for such an instrument in a high degree.

Mr. A. Noll, of Augustus Noll & Co., 10 and 12 East Sixteenth st., is one of the pioneers in the incandescent wiring business, in which he began many years ago in connection with the Edison system, when incandescent lighing was "in its infancy," and when construction work was little understood. During these early stages Mr. Noll introduced many improvements in principle and detail, and by this time he has probably wired for more lamps than any other man in the world. Mr. Noll has gathered fame and experience at the same time, and has seen the demand arise for a number of special fittings and supplies that are not, or have not been generally accessible in the market, though required for plants in breweries, dye-houses, oil-works, apartment houses, office buildings, theatres and marine warine work—all of which and many more he has wired up. Connected with Mr. Noll now in his business is Mr. Eidlitz, who is also an Edison graduate, and has had a long and varied experience in this department of the business. Mr. Noll has now organized, under New York laws, the New York Electrical Manufacturing Company, with a capital stock of $100,000—over $80,000 already subscribed—with offices at 10 West Twenty-third street and works at 154-156 West Twenty-seventh, where they are installing the latest machinery adapted for the production of electrical apparatus generally. The company have already secured the Barriett motor and dynamo, which has been illustrated in your columns, and they are satisfied that it will win its way strictly on its merits for perfect regulation, smooth running, coolness, etc. They also propose to manufacture electrical appliances generally, including special slate and marble switchboards for central and isolated plants. Mr. Noll will have general management of the manufacturing business, which will include also any kind of experimental work. Altogether prospects are excellent for the company, and Mr. Noll will leave no stone unturned under which a dollar for dividend may be found.

W. T. H.

WESTERN NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
39 Mallers Building, Chicago, Feb. 15, 1890.

The Time Electric Company, of Cleveland, has been incorporated, with a capital stock of $10,000.

The Fred. H. Whipple Company, of Detroit, has been incorporated with a capital stock of $5,000.

E. Dederick, a Milwaukee inventor, has invented an electric motor and motor truck for street railway service.

Mr. H. H. Small, of the Chicago office of the Thomson-Houston Electric Company, returned from St. Louis on Friday last.

The Mt. Clemens Electric Company, of Mount Clemens, Mich., has been duly incorporated with a capital stock of $25,000.

Mr. H. P. Lucas, the Western representative of Holmes, Booth & Haydens, returned to Chicago on Friday last after a very successful trip.

The Hyde Park Electric Light and Power Company, of Chicago, has filed a certificate of *decrease* of capital stock from $500,000 to $100,000.

Mr. W. H. McKinlock, president of the Central Electric Company, Chicago, made a flying business trip to the Southwest last week that proved quite successful.

Mr. Gilbert M. Smith, manager of the Chicago office of the Ansonia Brass & Copper Company, swung around the Eastern circuit last week with good results in the way of orders.

The Brush Electric Company, of Cleveland, have brought a new suit in the United States courts at Chicago, to restrain the Western Electric Company from infringing their patents.

The Bear Electric Company has been formed at Chicago to furnish electric light and power; capital stock, $3,000,000; incorporators, S. J. M. Bear, N. H. Hanchett and A. P. Willoughby.

The Parmelee Ore Concentrating Company has been incorporated at Chicago; to concentrate valuable ores; capital stock; $15,000; incorporaters, C. H. Crane, W. P. Hanna and L. D. Fisher.

The Sunbeam Incandescent Light Company has been formed at Chicago to manufacture and sell incandescent lamps; capital stock, $25,000; incorporators, Jean Elliott, F. W. Parker, D. Johnson.

The Proviso Light and Water Company, at Proviso, Ill., has been incorporated to furnish light, heat and water; capital stock, $15,000; incorporators, H. E. Broughton, Henry Struble and G. L. Thacher.

The Bessemer Gas and Electric Light Company, of Pueblo, Col., has been incorporated; capital stock, $100,000, divided in shares of $100. J. A. Dempsey, Rees Jones and H. Tritch are directors for the first year.

Shay, Stephens & Co., Chicago, are receiving large orders for their handsome glass socket, designed for holding incandescent lamps of any type, in places like packing houses, round houses, depots, etc., where moisture or fumes will destroy the metal socket usually furnished.

The Detroit, Mich., City Railway Company is reported to have sent an expert to England to inspect and report on the value of a new storage battery, with a view to using it on their lines should the wonderful claims made be substantiated. What's the matter with several different types of cells made in Michigan?

Shay, Stephens & Company, Chicago, are noted for the handsome little souvenirs they are constantly sending to their friends. As the demand for the handsome combined card case and pocket memo. has about exhausted the supply, they are now preparing a glass paper weight of special design, which they propose to lay on the desk of every member of the electrical fraternity.

Mr. P. C. Burns, manager of the St. Louis Electrical Company, visited Chicago last week. Referring to business prospects, Mr. Burns stated that they are unusually good, and that he contemplates opening a branch house in Chicago. At the present time they are making pins, brackets and cross-arms at Chattanooga, and porcelain branch boxes, cut-outs and rosettes at Findlay, O., where their glass battery jars and battery carbons are manufactured.

William Baragwanath & Son, Chicago, are running to their full capacity on feed water heaters of 500 h. p. and over. They are at work on the fourth 800 h. p. heater for Armour & Co., making about the fiftieth heater now in operation in the various packing houses in the West. As the exhaust steam used in these heaters is usually of a temperature of 214 degrees to 216 degrees Fahr. on leaving the engine, it easily heats the feed water to about 212 degrees, thus effecting a great saving in fuel.

A Valuable Engineer.—An economically inclined company recently placed a new man in charge of their incandescent plant who quickly proved his value by reporting that the customers were all pleased with the superior quality of light he was furnishing, but it was soon discovered that the lamps had to be replaced every few days, and an investigation made by the company furnishing the lamps showed that while the normal potential of the dynamo was 98 volts the engineer had increased the speed till the range of potential was from 112 volts to 128 volts. Is it any wonder that 98 volt lamps burned out?

Mr. S. Rosenstamm, representing Lewisohn Brothers of New York, was a welcome visitor to Chicago last week. Mr. Rosenstamm was en route to Kansas City, but a telegraphic message called him East again, and thus prevented his attendance at the Convention. Referring to the copper market, he said that Lake Superior wire bars, from which the wires are drawn, have advanced to 15 cents—a half cent higher than ingot copper, which is a rare occurrence, as both are usually rated at the same value. The present indications are that copper will advance fully a cent higher, although the manufacturers would much prefer to see it remain at present prices or go down rather than upward. The leading manufacturers have purchased all the copper required till April next. F. DE L.

THE TELEGRAPH.

Alexander, Va.—will probably have an electric fire alarm system.

Brunswick, Ga.—The city council has voted for an electric fire alarm system.

Western Union Telegraph Company.—The wires of the company have suffered terribly from the recent snow storms and blizzards in the Northwest, and it will be some time before the service is fully restored.

THE TELEPHONE.

Maryland.—A bill has been introduced in the Senate to tax foreign corporations doing business in Maryland, requiring foreign telephone companies to pay two per centum of gross receipts in the State, and electric light companies, one-half of one per centum.

Bell Telephone Stock.—The Boston *Herald* of Feb. 9 says: "Gossip speaks of more rights on Bell Telephone stock. They are expected later, but the payment of some $1,200,000 April 19 on the last subscription would indicate that the company would feel no pressing need of money for the present. The theory of investment buying is the best one heard to explain the rise in telephone stock."

Kansas City Electrical Society.—The members of the Old Timers' Association have joined the Kansas City Electrical Society, and they now act with that organization. Any telegrapher who has been in the service twenty years is eligible to membership in the Old Timers' Organization. This organization and the United States Military Telegraph Corps have worked together, as all the members of the military corps are eligible as Old Timers.

THE ELECTRIC LIGHT.

Montezuma, Ga., talks of putting in an electric light plant.

Yorkville, S. C.—It is intended to start a local Westinghouse Company.

Houston, Tex.—Thomas & Gorman are in the market for a six hundred 16 c. p. plant.

Natchez, Miss.—The Natchez Gas Company has put a new engine in for electric lighting.

San Antonio, Tex.—The Maverick Printing House wants a plant for 200 incandescent lights.

Richmond, Va.—A bill has been introduced in the Virginia Legislature allowing the city of Richmond to run electrical plants of its own.

Darien, Ga.—Abbott Thomas and Thomas S. Wylly, Jr., have been granted exclusive franchise to light the city by gas and electric light for 20 years.

Cordele, Ga.—D. J. McRae, N. T. Skinner and B. F. Toole have been appointed a committee to let the contract for an incandescent plant of 250 to 300 lights.

Newport, Ky.—The Newport Edison Electric Light and Heating Company is being formed with T. P. Caruthers, J. J. Hetsch, J. H. Mead and others as incorporators.

East Orange, N. J.—The Electric Lighting Company has been organized, with J. C. Bayles as president. The Edison system will be used for both domestic and street lighting.

Baltimore, Md.—It is proposed by J. E. Hooper, F. E. Walters G. Pool and others to incorporate the Woodberry & Belt Electric Light and Power Company, with a capital stock of $100,000.

Cleburne, Tex.—Max Elser, of Fort Worth, and W. H. Gaston, of Dallas, reported as purchasing the Cleburne electric light plant, have, with others, incorporated the Cleburne Electric Light and Gas Company. The capital stock is $20,000.

Winston, N. C.—The parties lately mentioned as purchasing the Winston electric light plant have organized as the Winston Electric Light and Street Railway Company, with F. J. Sprague, president; E. L. Hawks, vice-president; and J. H. McClement, secretary.

New Bedford, Mass.—The directors of the Edison Electric Illuminating Company and the New Bedford Gas Light Company, working the Westinghouse system of electric lighting, have voted to consolidate. The basis of consolidation is understood to be eight and a half shares of the latter stock for ten of the former.

Chillicothe, Mo.—The plant of the Chillicothe (Mo.) Water Works, Electric Light and Gas Company has been sold by Receiver W. E. Gunley, in the suit of the bondholders for default of interest, to A. G. Black, a New York capitalist and president of the reorganized company, for $50,000. The estimated cost of the plant is $85,000. The works were built by Comegy & Lewis, of New York, and, it is said, were bonded to English capitalists for $200,000.

Vancouver, B. C.—The Vancouver *News-Advertiser* says: Messrs. J. E. Winslow, of New York, and F. H. Osgoode, of Seattle, the gentlemen who have in hand the construction of the system of electric lighting and tramway service for the city, arrived last evening by the "Premier," and are at the Hotel Vancouver. In conversation with a *News-Advertiser* representative last evening, they stated that the work would speedily be begun and be pushed forward as rapidly as possible. The new station which is to be erected will be situated on the water front at the foot of Barnard street. Coal can thus be taken in at the station from boats. Tenders have already been invited for the erection of the building, and it is expected that three weeks after the tender is let the structure will be completed. In this building there will be eight dynamos and three engines of the latest and most approved pattern, made by Armington & Sims, of Providence, Mass. The engines will be 125 h. p. each. Three of the dynamos will be used for the arc lights and two of them for the railway work. It will not require more than one dynamo to drive all the cars which will be required for some time, but two will be put in, so that there may be a complete duplicate plant, and the danger of shutting down may thereby be rendered impossible. The boiler setting will be on the most perfect plan, and will be the third set in British Columbia on the principle adopted. The contract for setting the poles for the tramway line and also for the lights has been let, and the work will be commenced almost immediately. The wire for the lighting system is partly here and partly on the way. It is better material than has so far been put in any electric lighting system in British Columbia, superior quality of insulation being used. The cars will be built by George Stevenson, of New York one of the best builders in the United States.

APPLICATIONS OF POWER.

Jackson, Ga.—The Farmers' Alliance proposes to put in a dummy or electric road.

Augusta, Ga.—The Augusta & Summerville Street Railroad Company will equip with the overhead electric system.

Newark, N. J.—Property owners in Newark are showing themselves greatly averse to an electric road with the overhead system. Their conversion is expected, however.

New York City.—Another cross-town street railroad has been incorporated, and the articles have been filed. The capital stock is to be $500,000, and the directors are Frederick A. Bartlett, Horace M. Ruggles, C. E. James, John W. Mersereau, Robert A. Greacen, F. C. Pemberton and Jared F. Harrison. The title of the company is the Fiftieth Street, Astoria Ferry and Central Park Railroad of New York. The route proposed is as follows: Beginning at Fifty-seventh street and North River, through that street to Eleventh avenue, thence to Fifty-fourth street to Tenth avenue to Fiftieth and Fifty-first streets; thence to Park avenue, across the railroad bridge between Ffity-first and Fifty-second streets; thence through Fiftieth and Fifty-first streets to First avenue to Fifty-third or Fifty-fourth street to Avenue A, to Ninety-third street, to First avenue, to Central Park. Branches of the road will run through Sixty-fifth and Sixty-sixth streets, from Avenue A to Central Park; through Ninety-sixth street, from Avenue A to Madison avenue and to Central Park at Ninety-seventh street, and others running to possible ferries on the East River. The length of the road, with branches, will be about 7¾ miles. The new company is practically the same as that about to operate in Twenty-eight and Twenty-ninth streets, and there is plenty of money behind the enterprise. Both roads are to be operated by electricity.

PERSONALS.

MM. de la Touanne and Seligman Lui are now in this city investigating the telegraph and telephone service for the French Government.

Mr. W. A. Smith, General Manager of the Omaha Street Railway Company, came to Chicago this week to order fresh supplies for his road.

Dr. Michael Pupin has been designated as "Instructor of Mathematical Physics" in the Department of Electrical Engineering at Columbia College, where he is already associated with Mr. F. B. Crocker.

Mr. T. A. Edison, on the occasion of his forty-fifth birthday last week, was the recipient from the employees of the Edison Phonograph Works of a very handsomely mounted phonograph of the latest pattern. It is now at his residence in Llewellyn Park.

MISCELLANEOUS NOTES.

The "Old South."—The North Side Street Railway Company Fort Worth, Tex., has resolved to stick to mules as motive power. May the Lord be with them!

Link Belts in the Chicago Auditorium.—With reference to the recent article in your columns, on the electrical plant at the Chicago Auditorium, wherein it was stated that leather link belts are used, I think it might interest many to know that they are Eastern belts, made by the American Leather Link Belt Company, of 46 and 48 Ferry street. Mr. F. A. M. Burrell, the treasurer of the company, who was recently in Chicago, tells me that the plant is running beautifully, and is a model.

The New England Phonograph Company gave an interesting exhibition of its instruments at its rooms in the Boylston building one day this week, which attracted a great deal of attention. Mr. Edison is now reported to be at work upon an invention by which the receiving cylinder is done away with. The invention consists of a material not much thicker than ordinary writing paper, which is placed around a wooden cylinder to receive the message, and can then be placed in an ordinary envelope for mailing.

California Electrical Society.—At the annual meeting of the California Electrical Society, held at Harmony Hall, 121 Eddy Street, Monday Evening, Feb. 3d, 1890, the following officers were elected for the ensuing year: President, Prof. N. S. Keith; Vice-President, Orion Brooks; Secretary, Wm. W. Wight; Treasurer, W. W. Hanscom; Members of the Executive Committee, E. A. Roe, A. W. Smith and H. T. Bestor. The following honorary members were elected: A. G. Davis, Baltimore, Md.; George H. Pride, New York, N. Y.; L. L. Baker, P. B. Cornwall, and Alvinza Hayward San Francisco, Cal.

The Automatic Phonograph Exhibition Company of New York City was incorporated in this State to-day, with a capital stock of $1,000,000. It is formed to manufacture, lease, use, and sell a nickel-in-the-slot machine, by means of which the dropping of a coin in the slot will operate a mechanism which will cause a phonograph or phonograph-graphophone to produce the sound recorded upon its cylinder, and after such reproduction cause the diaphragm to return to its original position. The trustees of the company are Felix Gottschalk, Willard L. Candee, Thomas T. Eckert, Jr., Richard W. Stevenson, Victor E. Burke, John E. Prague and James Molinari.

The Niagara River Hydraulic Tunnel, Power and Sewer Company—will now, it is stated, carry out its plans for utilising the fall of water at Niagara, by building its main tunnel and connecting cross tunnels with wheel pits. The estimate of cost is $2,250,000. It is estimated that if thirty mills of 500 h. p. each are built, it would pay five per cent. upon a capital of $3,000,000, while if all privileges were taken, the result would pay the interest upon a large block of bonds and a handsome return upon the stock. One of the best-known banking houses in Wall street is deeply interesting in this undertaking. The scheme is one of sound engineering and is thoroughly practicable.

Controlling the Phonograph and Graphophone.—It was announced last week in New York that a syndicate, composed of several prominent capitalists, among them Henry G. Marquand, D. O. Mills, Jesse Seligman and J. M. Waterbury, of New York and John Wanamaker and Thomas Dolan, of Philadelphia, had purchased the foreign graphophone patents for $50,000 cash. Inquiry elicited the fact that arrangements had been perfected with Mr. Edison by which a new company is being formed to control both machines in all countries outside of the United States and Canada. One of the Philadelphians comprising the syndicate said: "There has been such a syndicate formed, and those who comprise the syndicate are: D. O. Mills, H. G. Marquand, H. H. Cook, W. Martin Grinnell, Jesse Seligman and J. M. Waterbury, of New York, and Thomas Cochran, William Wood, Geo. H. McFadden, Thomas B. Wanamaker and Thomas Dolan, of Philadelphia. John Wanamaker, the Postmaster-General, is not in the syndicate. The company will have possession of all machines and instruments under the patents, and the capital backing the syndicate is unlimited. The particulars will be developed in a few days."

BUSINESS NOTICES.

Ball Engines.—In connection with the interesting paper read before the Convention at Kansas City by Mr. C. J. Field, on the new Brooklyn Edison station, it may be mentioned that C. R. Vincent & Co., 15 Cortlandt street, this city, Eastern agents for the Ball Engine Company, closed the contract for twelve of the Ball engines mentioned.

"The Western Engineer."—We are in receipt of a copy of this publication, which is being issued by the Pond Engineering Company, of St. Louis, as a means of advocating their work, appliances, etc., and also as a channel for new and useful information on mechanical and engineering subjects. It promises to do excellent educational work, and has our best wishes.

Houston's Electrical Dictionary.—Speaking of the Dictionary, the *Journal of the Franklin Institute* says: The author has placed not only the electrical engineers, but also the great body of those who have to do with electrics, professionally or in a business way, under great obligation in the preparation of this very complete dictionary. The absence of a general work of reference, giving the exact meaning of the many new terms and phrases introduced into the terminology of this rapidly advancing branch of knowledge, has long been a serious inconvenience, and no more timely and welcome publication in this field could have been made than the dictionary. It is a substantial compensation to those who have so severely felt the need of such a work that at length it should have came from the pen of so experienced, thoroughly competent and care-taking an author as Prof. Houston, and his production will materially strengthen his reputation as an author. The work presents some unusual features, which would not be anticipated from its title, in being far more than a mere list of terms and phrases with definitions condensed into the smallest possible space. On the contrary, it is rather an explanatory and illustrated treatise, so fully and satisfactorily are the more important and difficult portions of the subject treated. The illustrations, with which the work is profusely embellished, substantially enhance the value of the book. Many of these illustrations are new, having been specially prepared for the work, and all are well executed. Taking it all in all, the work is one of the most useful of recent additions to technical literature. In respect of typography the publishers have left little to be desired.

Beck Automatic Engines.—Among recent sales and installations of Beck automatic engines and complete steam plants, the Taylor Manufacturing Co., Chambersburg, Pa., report the following: *For Operating Electrical Coal Mining Machinery*—One 11½x15 automatic engine for Sterling Mining Company, Canneiton, Pa., and three 11½x15 engines for the Upper Monongahela Coal and Coke Company, of Fairmont, W. Va. *For Electrical Street Railway Service*—Two 14½x15 automatic engines, with boilers, etc., to the Chattanooga, Tenn., Electric Street Railway Company, and one 11½x15 with complete steam plant for the Capital City Street Railway Company, Salem, Oregon. *For Electric Light and Power*

Service, as follows: One 12½x15 engine to Charleston, S. C., Cotton Mills; one 8½x10 and one 9½x12 engines with boiler, etc., to Hackensack Edison Electric Light Company, Hackensack, N. J.; one 13½x15 engine with complete plant to W. M. Kurtz, New Philadelphia, O.; two 11½x15 and one 14½x18 engines to Gregory & Co., California; one 10x10 engine for Baxter Court House, Memphis, Tenn.; one 10½x12 engine for Lawrence Co. Lumber Company, Summertown, Tenn.; one 9½x12 engine with boiler, etc., to White & Ballard, Washington Court House, O.; one 15x18 engine to Merchants Electric Light and Power Company, Birmingham, Ala. (second engine); two 14½x18 engines with boilers, clutches, etc., for Thomson-Houston Electric Light Company, Bradford, Pa.; one 7x8 engine for Chicago & Grand Trunk Railroad Company, Detroit, Mich.; one 10½x12 (making second engine sold them) to Natchez, Miss., Gas and Light Company; one 14½x15 engine with complete steam plant to Tuscaloosa, Ala., Electric Light Company; one 18½x24 engine to Hughes Lumber Company, Chattanooga, Tenn.; one 11½x15 engine with complete steam plant to Town Council, Chambersburg, Pa., operating Thomson-Houston arc plant; one 8½x10 engine with boiler to Lock Company, Directors, Clarks Summit, Pa; one 12½x15 engine with complete steam plant to Punxsutawney, Pa., Electric Light and Power Company; one 8½x10 engine for Welles Building, New York City; one 16x18 engine to T. C. & H. A. Gooch, Louisville, Ky.; one 12½x15 engine to Jones Brothers Electric Company, Cincinnati, Ohio; two 11½x15 engines to United States Trust Company, New York City; one 9½x12 engine for George Brooks & Son, Philadelphia, Pa.; one 11x12 engine to J. O. Shoup & Co., Dayton, O.; one 9½x12 engine with boiler to J. H. Cramer, Jr., Piedmont, W. Va.; one 10½x12 engine (making third engine sold them) to Jones & Laughlin Company, Pittsburgh, Pa.; one 11½x15 and one 10½x12 engines to W. Oswald, New Orleans, La.; one 9½ x 12 engine for New Iberia, La.; Electric Light and Power Company; one 10½x12 engine for Pittsburgh Plate Glass Company, Creighton, Pa.; one 9½x12 engine to J. P. Witherow, New Castle, Pa.; one 11x12 engine to the Ashland, Ky., Electric Light and Power Company; one 9½x12 engine to Read House, Chattanooga, Tenn.; one 11x12 engine with complete steam plant for Lookout Mountain Hotel Company, Chattanooga, Tenn.; one 10½x12 and one 10x10 engine to Becford Electric Company, Liberty, Va; one 8½x10 engine for appartment house, Fifth Ave. and 30th street, New York. *For Export for Electrical Service.*—One 7½ x 8 automatic engine to the Eureka Electric Co., New York, for export to Cuba; one 7¼ x 8 engine for Goldie & McCulloch, Galt, Ontario, Canada. The Taylor Company also report the sales of a number of their vertical automatic engines on combination base for dynamos, which style engine is spoken of quite highly for isolated electrical work, and which was also illustrated in THE ELECTRICAL WORLD some time since, and full information regarding which can be obtained of the company; one 7 x 7 cylinder vertical engine for Thomson-Houston Electric Light Company., Detroit Mich; one 5½ x 6 engine for Columbia River Paper Company, La Camas, Washington; one 5x6 engine for Cochrane Lumber Company, and Bohlen Huse Ice Machine Company, both of Memphis, Tenn., and driving Edison dynamos.

OUR ILLUSTRATED RECORD OF ELECTRICAL PATENTS.

PATENTS ISSUED FEBRUARY 4, 1890.

420,441. Thermal Cut-Out; George Farrell, of New York, N. Y. Application filed April 26, 1889. The combination, with a fusible wire in the circuit, of a circuit breaker in normal contact with the fusible wire and in operative relation to the armature of a magnet in circuit with the wire and circuit breaker.

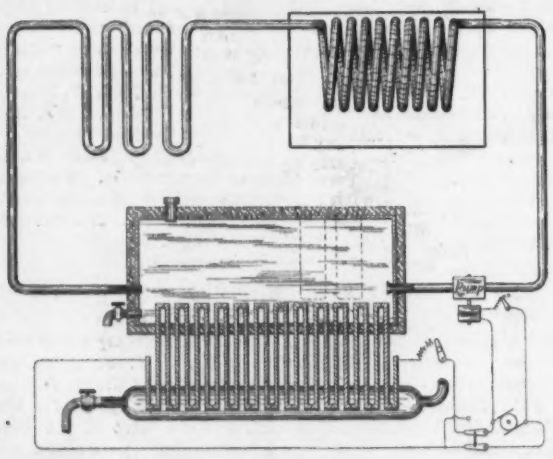
420,469. Regulation of Electric Motors; Lemuel W. Serrell of Plainfield, N. J., and Harvey L. Lufkin, of New York, N. Y. Application filed May 8, 1888. The combination, with the main exciting coil of an electric motor, of a differential coil in parallel with the main exciting coil, both coils being in series with the armature, and a speed governor controlled by the motor and controlling the current flowing through the differential coil in accordance with the work done.

420,552. Extension Electroller; James E. Brown and John F. Brown, of Brooklyn, N. Y., Assignors to the Archer & Pancoast Manufacturing Company, of New York. Application filed Sept. 11, 1888. In an extension electroller, the combination of a stationary tube, a tube fitting and sliding therein, and a spiral conductor arranged above the sliding tube and having its coils in line and fitting snugly in the stationary tube, whereby the coils are guided by the stationary tube and cannot pass one another.

420,594. Quadruplex Telegraph; Thomas A. Edison, of Menlo Park, N. J., Assignor to the Western Union Telegraph Co., of New York, N. Y. Application filed August 22, 1877. The combination, in a quadruplex telegraph, of an electro magnet in the main line circuit and an armature set to respond to maximum and medium strength of current and a sounder brought into action by such armature, a second electro-magnet in the main line circuit, and an armature set to respond to medium and minimum strengths of current, and a sounder and local circuit brought into action by such armature.

420,611. Electric Brush; John E. Stephens, of Cincinnati, O. Application filed Dec. 2, 1889. In an electric brush, the combination of the back having two cavities forming separate chambers within it, metallic holders fitted within the cavities, the rubbing substances secured to the holders and the battery wires, passing through the handle and connected to the metallic holders.

420,622. Electrical Lock-Switch; Edward N. Dickerson, Jr., of New York, N. Y. Application filed Jan. 16. 1888. The combination of the switch making opposite connections and moved



420,641.—METHOD OF ELECTRIC REFRIGERATION.

by two controlling magnets with an independent mechanical lock locking the switch in each of its two connections, the mechanical lock being controlled by an independent magnet in the circuits with both of the controlling magnets.

420,635. Staple for Electrical Conductors; Luther Stieringer, of New York, N. Y. Application filed Aug. 26, 1889. An open sided metal staple adapted to be driven and provided with a saddle of insulating material secured thereto, so as to present a body of insulation between the metal head of the staple and the wire. See p, 116, this issue.

420,638. Cable-Hanger; William A. Conner, of Pittsburgh, Pa. Application filed March 10, 1888. A cable hanger consisting of a hook for engagement with the suspensory wire and a rigidly flexible band for grasping the cable, the hook and band being formed integral with each other.

420,641. Method of Electric Refrigeration; Mark W. Dewey, of Syracuse, N. Y., Assignor to the Dewey Corporation, of same place. Application filed November 15, 1889. The invention consists in subjecting a medium to a temperature changing effect produced by an electric current in one or more parts of an electric circuit and in circulating the medium through a conduit or pipe leading to or through a locality wherein the temperature is to be changed. See illustration.

420,693. Electro-Magnetic Car-Brake; Daniel S. McElroy, of New York, N. Y. Application filed June 29, 1889. The invention consists in the combination, with the car and ordinary car-brakes, of an electric motor adapted to operate the car-brakes without interfering with the action of the hand-brakes.

420,697. Burglar Alarm; Noah M. Powell, of Reger, Mo. Application filed Aug. 17, 1889. The combination, with the frame adapted to support the safe, a scale platform suspended therefrom, a housing placed over the safe and resting on the platform, and the scale beam, of an alarm bell in an electric circuit, a circuit breaker formed in the circuit and disposed in connection with the scale beam, the breaker adapted to be operated by the movement of the scale beam.

420,705. Electric Lamp Adapter; James Stewart, of New York, N. Y., Assignor of one-half to Edmund C. Stanton, of same place. Application filed Aug. 4, 1888. The invention consists in a cup-shaped disc of insulating material provided with forked springs connected with electrodes capable of contacting with the electrodes of the socket, the disc having key slots for receiving the studs of a lamp and guiding them to engagement with the forked springs.

420,706. Electric Lamp Adapter; James Stewart, of New York, N. Y., Assignor of one-half to Edmund C. Stanton, of same place. Application filed Aug. 4, 1888. The invention consists in a hollow button of insulating material containing two flat, curved springs provided with a screw-threaded peripheral band of metal and furnished with changeable contact screws.

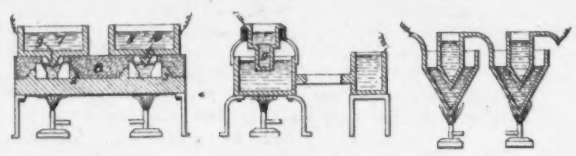
420,710. Bipolar Prostatic Electrolyzer; Richard Meade of Philadelphia, Pa. Application filed Dec. 6, 1889. A bipolar prostatic electrolyzer consisting of rectal and perineal electrodes and stems carrying the same and connected together, but capable of movement in respect to each other.

420,740. Electric Belt; Albert J. Sheffield, of Griggsville, Ill. Application filed July 24, 1889. The combination, with the belt, of a battery formed of cells and links, the battery being provided with hooks, each of the hooks being constructed of wire which is bent to form a V-shaped point on the same plane with the parts which form the shank of the hook.

420,762. Electric Meter; James D. Bishop, of Chicago, Ill. Application filed June 17, 1888. In a registering meter for electric currents the combination, with the solenoid core and registering mechanism, of a compensator having a cam, adjustable as to the degree of its curve and secured upon a lever, and the cord holding a cam to the yielding resistance against rotation by the said lever.

420,764. Thermo-Electric Generator; Charles S. Bradley, of Yonkers, N. Y. Application filed June 17, 1889. A thermo-electric generator having an element which remains solid at the highest working temperature, in combination with an element which becomes fused at the hot junction. See illustration.

420,771. Elevator; John H. Clark, of Boston, Mass. Application filed Jan. 31, 1889. The invention consists in the combination with an elevator car and a motor mechanism to move it, of an



420,764.—THERMO-ELECTRIC GENERATOR.

electric device to control the operation of the motor mechanism, a switch carried by the car provided with circuit terminals, and a speed regulating device connected to the electric device and to the circuit terminals on the car, whereby the speed or rate of movement of the elevator car may be regulated.

420,801. Conduit for Electric Railways; Delbert E. Johnson, of Atlanta, Ga. Application filed March 7, 1889. Renewed Jan. 11, 1890. In a conduit for electric railways, the combination, with a flat track rail resting on a supporting yoke piece, of a cover rail, the two rails forming the margins or walls of the slot, and the cover rail consisting of the flat plate resting upon the top of a second yoke piece formed in one piece with a supporting foot piece, and having a depending flange forming one wall of the slot, and metallic lining-sections resting at their ends between ribs on the yoke pieces.

420,816. Electrically Reciprocated Tool; Harry N. Marvin, of Syracuse, N. Y. Application filed Nov. 19, 1889. The invention consists in the combination of a reciprocating tool composed of a magnetic plunger and two oppositely acting coils, the generator having a single induced or current generating circuit, two working circuits from the generator to the tool, and a commutator or current shifter mechanically connected with the movable element of the generator and adapted to connect the terminals of the generating coils alternately with the working circuits.

420,833. Autographic Telegraph; James H. Robertson, of Brooklyn, Assignor to the Writing Telegraph Company, of New York, N. Y. Application filed Feb. 3, 1885. A sending stylus or contact maker, provided with two contact points, in combination with two sockets connected to ground, in which sockets the stylus is held when not in operation.

420,834. Electric Door-Opener; George A. Seib, of New York, N. Y., Assignor of one-half to Otto Starke, of same place. Application filed Aug. 1, 1889. The combination of an electro-magnet, an armature operated by the same, a fulcrumed and spring actuated elbow lever abutting against the armature, an intermediate pivoted and spring actuated locking lever, the outer end of which is engaged by the shorter arm of the elbow lever, the lever being provided with a stop shoulder that is engaged by the stop shoulder of the intermediate locking lever, the latch having a projecting portion for engaging or releasing the spring bolt of the door to be opened.

420,840. Electro-Magnetic Abdominal Support; Mary E. Thomas, of Cardington, Ohio. Application filed Oct. 7, 1885. In an electro-therapeutical appliance, the combination of a galvanic pile consisting of plates of zinc and copper and an intermediate sheet of absorbent material, an outer covering of non-conducting material protecting one side and having the marginal portions bent over to receive the plates and sheets, and a stud extending from the outer element through the non-conducting material, together with a conducting wire connected to the stud and adapted to be placed in electrical contact with the person of the wearer.

(1) 420,850. Electrical Recording Instrument; (2) 420,852. Apparatus for Electrically Recording Signals; Frank B. Wood, of New York, N. Y., Assignor to The E. S. Greeley & Co., of Connecticut. Applications filed (1) May 9, 1889; (2) Sept. 23, 1889. In an electrical time recording mechanism, the combination of independently revoluble time indicating wheels, provided with ratchets, one of the ratchets having a peripheral notch, and pawls pivoted to an armature and provided with a uniting pivotal cross-piece and adapted to respectively engage the ratchets. (2) In an electrical recording instrument, the combination, with the time indicating device and its actuating mechanism and the signal receiving device and its actuating mechanism, adapted to co-operate with the time-indicating device to record a signal, of a lever, one arm of which is pivotally connected to the armature of the magnet of the actuating mechanism of the signal-receiving device, and the other arm of which is adapted to engage and disengage the pallet, working to the escapement of the actuating mechanism.

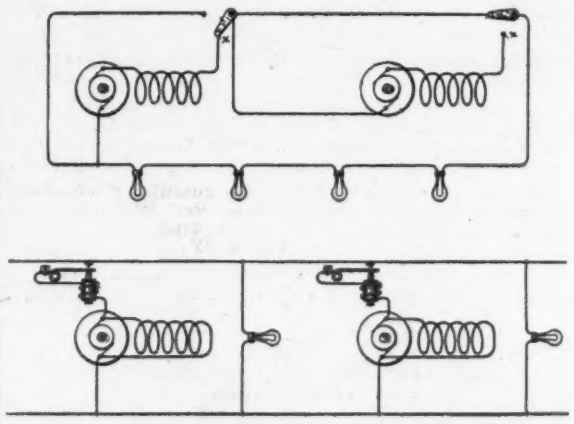
420,851. Method of Electrically Recording Signals; Frank B. Wood, of New York, N. Y., Assignor to The E. S. Greeley & Co., of Connecticut. Application filed May 14, 1889. The method of electrically recording signals, which consists in imprinting upon a recording medium the figures indicating the time at or about which the signal is recorded in a succession of impressions corresponding in number and relative location to, and representing the number of, the signal.

(1) 420,858. (2) 420 859. Electric Railway Signals; George W. Boss, of Minneapolis, Minn. Applications filed (1) March 8, 1889; (2) Sept. 26, 1889. (1) A railway signal system comprising, in combination, a main wire provided with ground connections and contact strips at each end, a local circuit provided with a suitable signal, a local circuit-closer magnet arranged in the main wire, and a train or engine carrying a battery or equivalent having a ground connection and a brush adapted to be brought into contact with the contact strips, whereby as the engine or train passes either of the contact strips the local circuit will be closed and the signal in the local circuit will be operated. An electric railway block signal, comprising, in combination, a main line having a ground connection at each end, a contact strip in the line at each end, a relay at the line in each end arranged between the contact strips and the ground connection, a signal at each end adapted to be operated by the relay, a contact strip arranged in proximity to the first named contact strip and insulated therefrom, wires connected one to each of the last named contact strips, each provided with a suitable battery, and having a ground connection, and a brush carried by an engine or train, and adapted to be simultaneously brought in contact with both of the contact strips at either end of the block.

420,881. Filament for Incandescent Lights; Rudolf Langhans, of Berlin, Germany. Application filed April 5, 1888. Patented in Germany, Nov. 9, 1887; in France, Feb. 15, 1888; in England, Feb. 18, 1888; in Belgium, Feb. 20, 1888, and in Italy, Feb 21, 1888. A filament for incandescent electric lamps consisting in a vein or core composed of salts, the basic component of which consists of an oxide or oxides of earthy metal, and the acid component, of that class of oxides which in presence of the former and on exposure to high temperature assume the character of acids, the vein or core being coated with material of higher electric conductive capacity than the core.

420,882. Electric Regulating Mechanism; Hermann Lemp and Merle J. Wightman, of Hartford, Conn., Assignors to the Schuyler Electric Co., of Connecticut. Application filed June 21, 1887. The invention consists in the combination, with a motor mechanism, of a retarding device having a variable retarding effect in both directions of movement of the mechanism, which effect is governed or adjusted automatically by the controller magnet, or by a magnet in circuit therewith or controlled thereby, and either directly or indirectly in such way that the magnitude in the change in the power of the controller magnet shall effect a corresponding change in the adjustment of the retarding mechanism, so that with a large change the latter shall retard the motor mechanism to a less degree, and therefore allow a quick or rapid movement of the same in either direction.

420,884. Multiple Telegraphy; Ernest Jules Pierre Mercadier, of Paris, France. Application filed Aug. 16, 1888. Patented in France, May 30, 1888; in England, July 17, 1888; in



420,924.—SYSTEM OF GENERATORS.

Germany, Aug. 16, 1888, and in Belgium, Aug. 28, 1888. The method consists in producing electrical undulations bearing the characteristics of two or more sets of as many distinct rhythms by and in accordance with rhythmical impulses of radiant energy, and thereby producing sound waves in sets of the different rhythms.

420,890. Electric Time Alarm and Indicator; Charles Adams Randall, of London, England. Application filed June 13, 1889. The object of the invention is to provide a novel time alarm or indicator for automatically giving notice of the arrival of predetermined periods of time, and is more especially designed for notifying a person or persons of the arrival or approach of the time for keeping appointments, engagements and the like.

420,894. Rheostat; William Thomson, of Glagow, County of Lanark, Scotland, Application filed Oct. 4, 1888. The combination of the cylinders, the guide, guide rollers, and a nut, carrying the guide and guide roller, with a screw shaft, on which the nut travels, the shaft being geared to the cylinders and the nut being prevented from rotating.

420,906. Apparatus for Charging and Discharging Secondary Batteries; Warren S. Johnson, of Whitewater, Assignor of one-half to William Plankinton, of Milwaukee, Wis. Application filed Feb. 2, 1885. In commutators for secondary batteries, the combination of a slide having upon it two or more series of contact pieces arranged so that a change of the position of the slide in relation to the terminals or poles of the secondary batteries will commute the currents differently, the poles or terminals of a series of secondary batteries, and an electro-magnet or solenoid in circuit, so that the starting of the current will commute it differently.

420,924. System of Generators; Addison G. Waterhouse, of Hartford, Conn., Assignor to the Westinghouse Electric Company, of Pittsburgh, Pa. Application filed May 3, 1889. The combination, with two or more dynamo electric generators, and a single work circuit supplied thereby, of an automatic cut-out controlled by currents delivered by one of the generators for automatically removing the same from the circuit when the current delivered thereby falls below a predetermined amount. See illustration.

PATENT EXPIRED JAN. 28, 1890.

135,334. Telegraph Insulators; Nathan Hendricks, of Jersey City, N. J. The object of this invention was to improve insulators for telegraph wires by inserting the head of the bar to which the wire is attached between two blocks of glass, which are confined by means of a base plate and removable supporting pins within a flanged box of suitable shape.

Copies of the specifications and drawings complete of any of the patents mentioned in this record—or of any other patents issued since 1866—can be had for 25 cents. Give the date and number of patent desired, and address The W. J. Johnston Co. Ltd., Times Building, N. Y.